Calibration and Switching Module

User's Manual

A Swagelok® Pre-Engineered Subsystem

Swagelok

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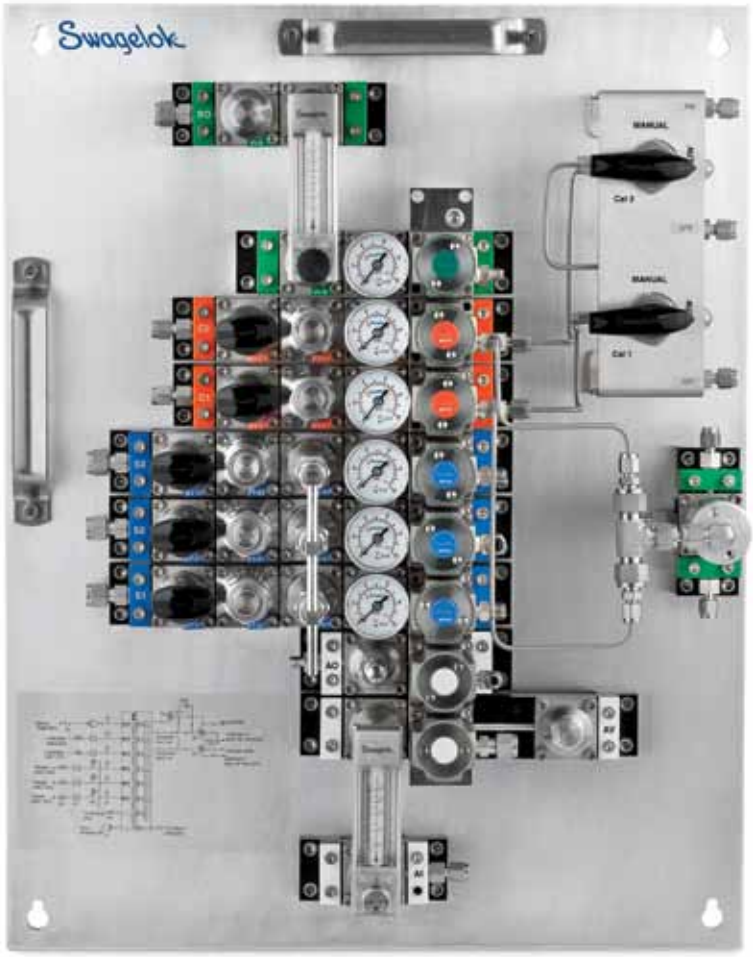
Calibration and Switching Module (CSM)

System Manual

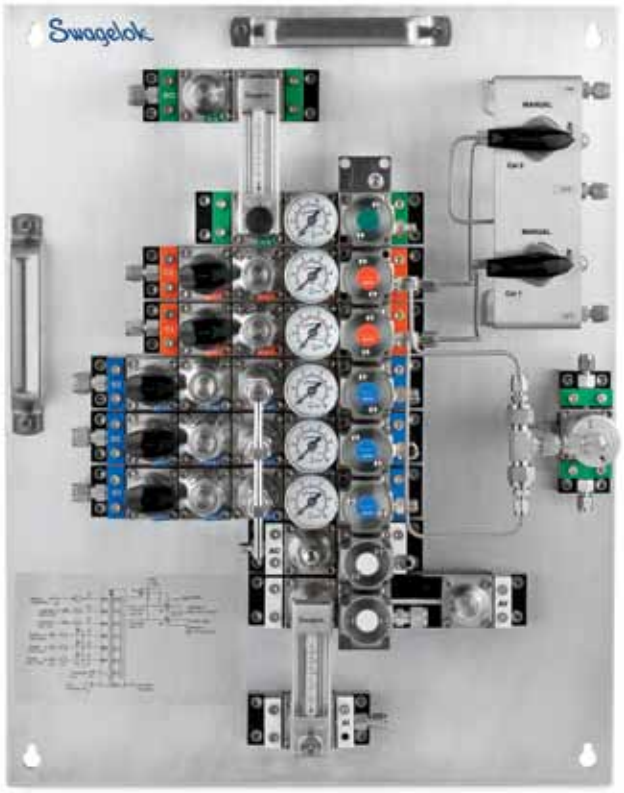


Gas System with Three Sample Inlet Assemblies and Two Calibration Inlet Assemblies
Shown with Bypass, ARV, and Manual Calibration Options

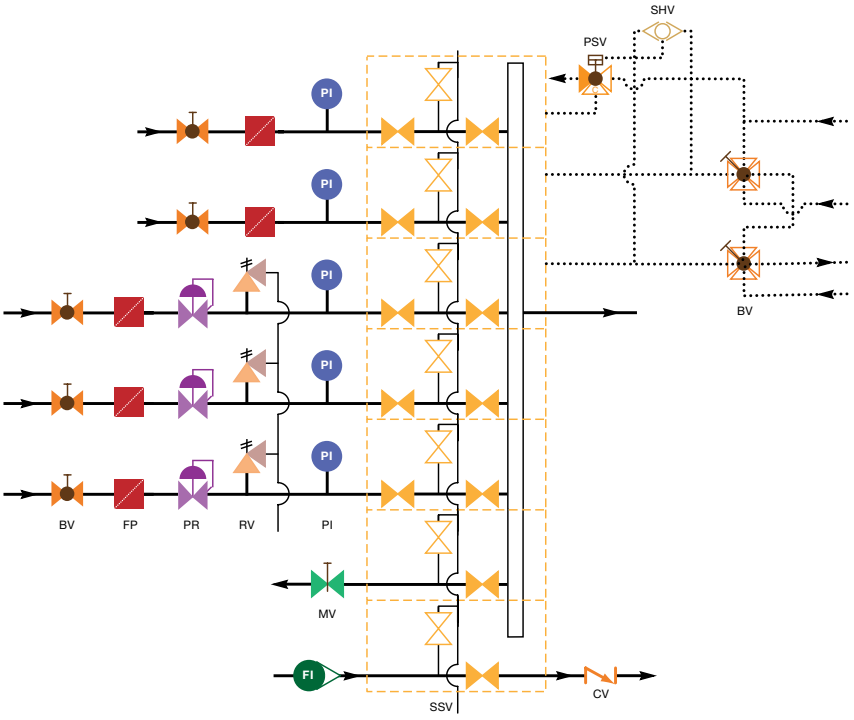
Introduction

The Calibration and Switching Module (CSM) is a part of an analytical sampling system. The CSM selects the process or calibration fluid, which is then directed to a process analyzer. The CSM contains multiple streams with modular components, including a stream selector system (SSV series). The series of components which handle the process fluid are called sample inlet assemblies. The series of components which handle calibration fluids are called calibration inlet assemblies. The SSV within each stream selects a fluid for analysis in response to a pneumatic-pressure signal from an external source, typically the analyzer. The signal opens one of the SSV's double-block-and-bleed valve modules corresponding to the stream containing the fluid to be analyzed. The selected fluid flows through the CSM to the process analyzer.

Introduction



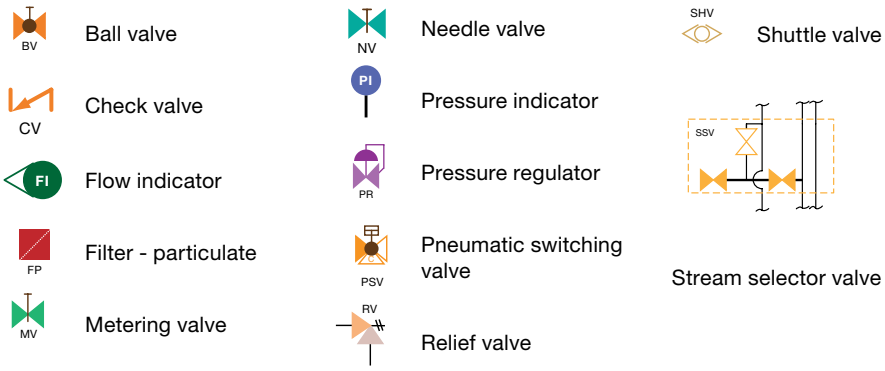
Gas System with Three Sample Inlet Assemblies and Two Calibration Inlet Assemblies Shown with Bypass, ARV, and Manual Calibration Options



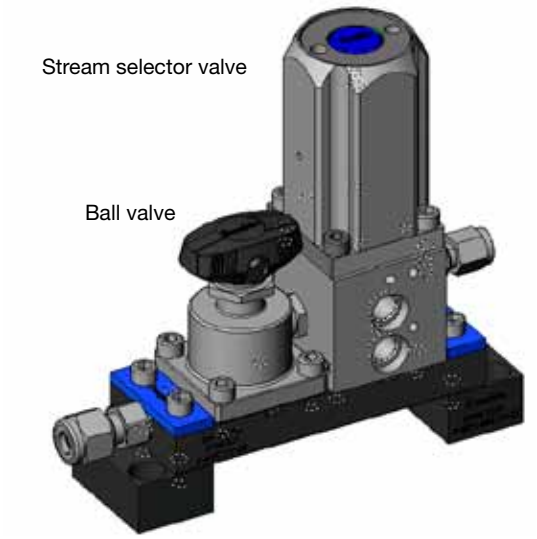
Inlet Assembly Configurations

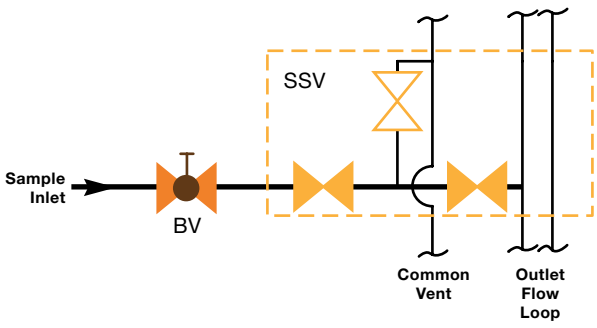
Your CSM will be configured using one of these six inlet assemblies plus any selected outlet configuration and options. See the *Calibration and Switching Module Application Guide*, MS-02-360, for additional information.

Configuration Symbols



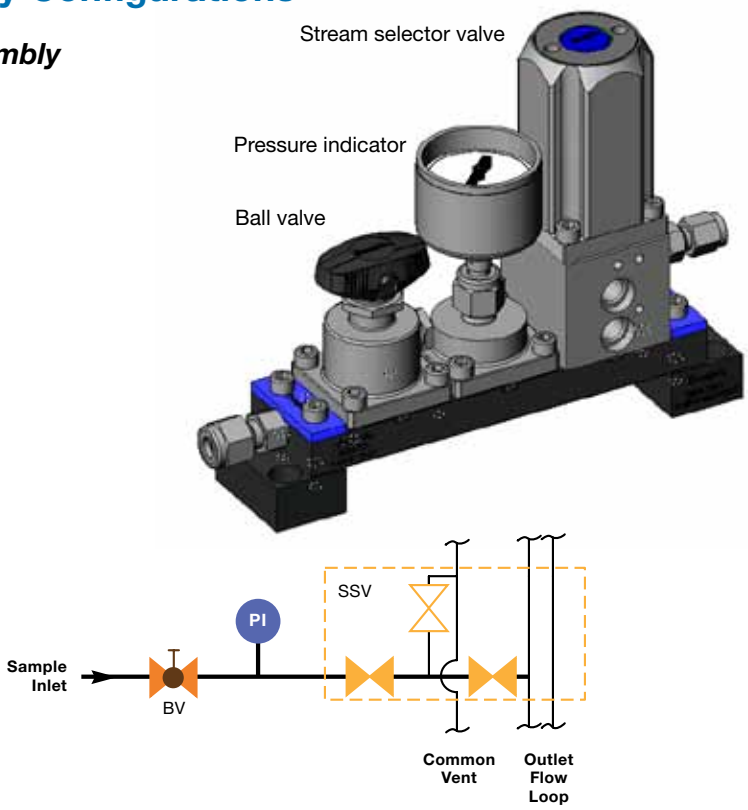
Valve Inlet Assembly (VIA)





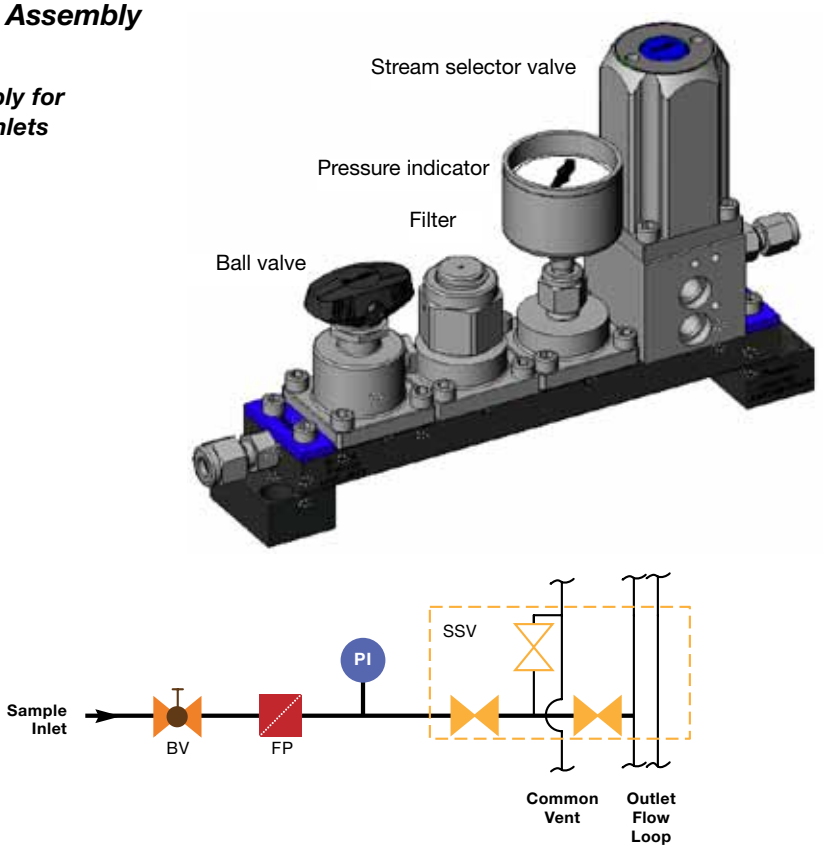
Inlet Assembly Configurations

Gauge Inlet Assembly (GIA)



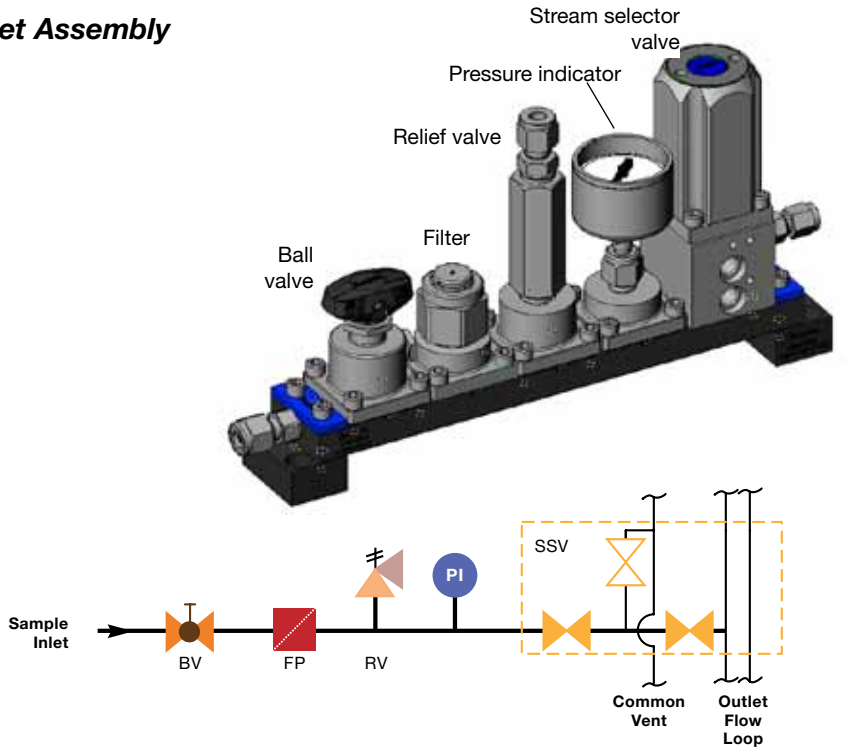
Filter Inlet Assembly (FIA)

Only assembly for calibration inlets

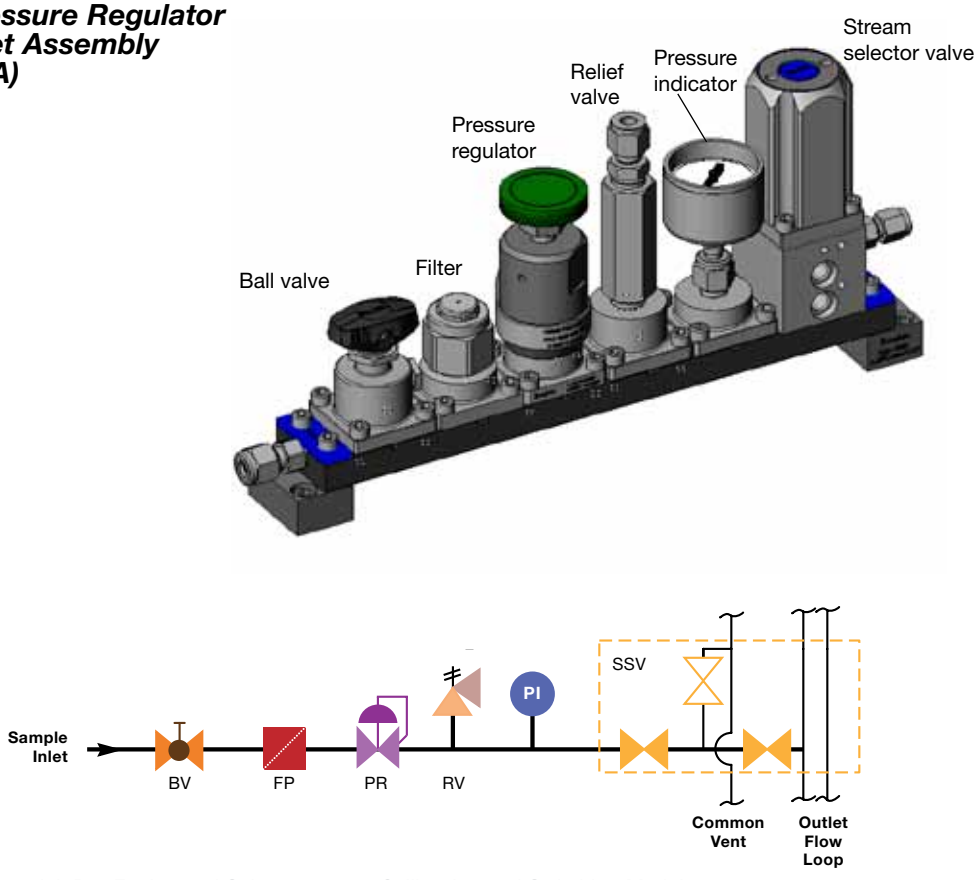


Inlet Assembly Configurations

Relief Inlet Assembly (RIA)

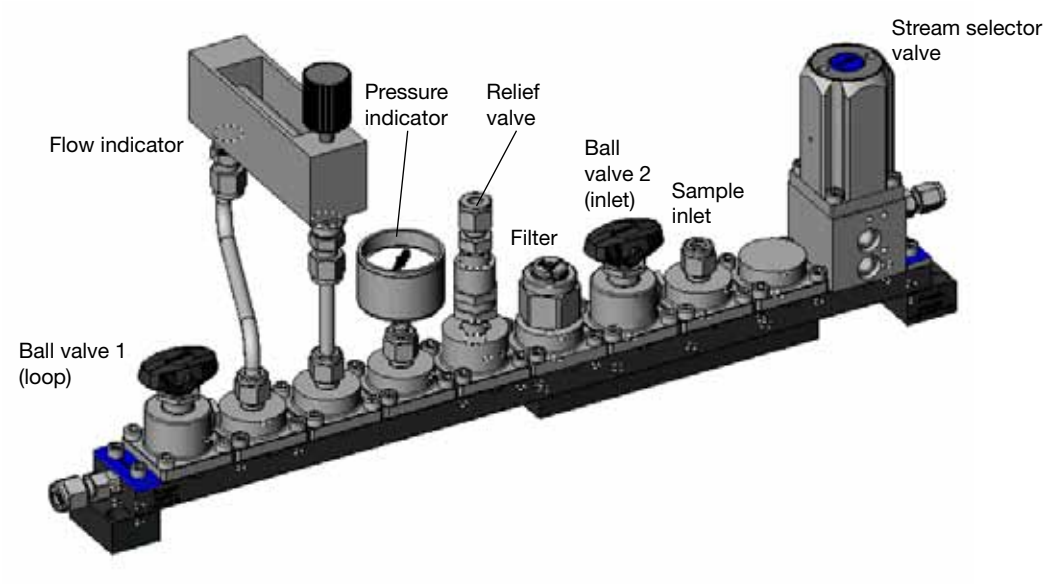


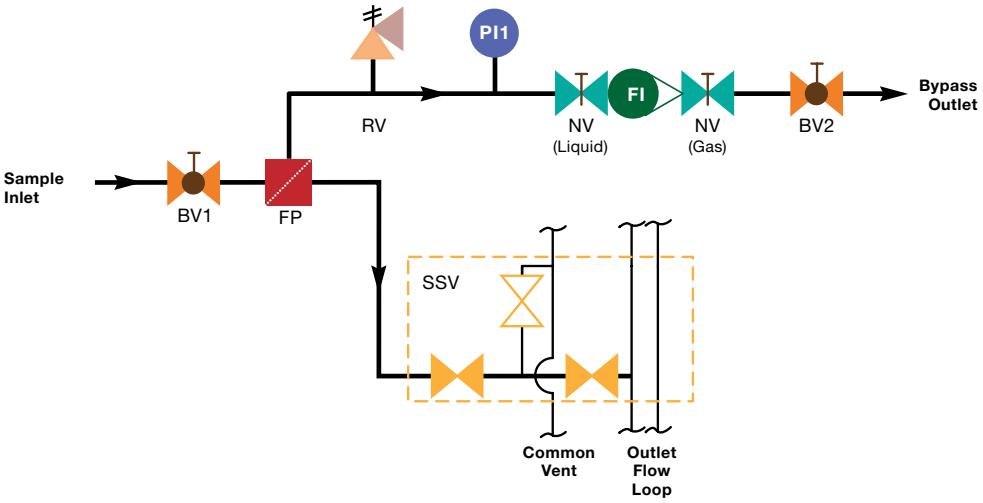
Pressure Regulator Inlet Assembly (PIA)



Inlet Assembly Configurations

Flow Loop Inlet Assembly (LIA)





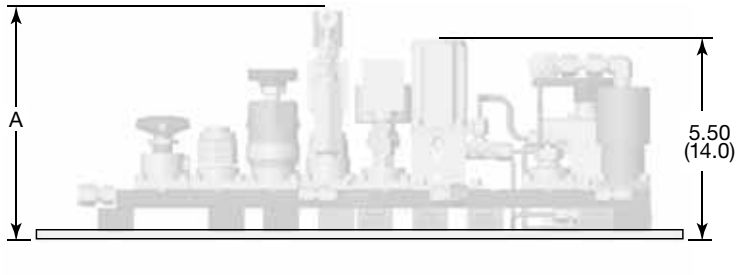
Mounting

The size of the mounting plate is dependent on the number and type of sample streams, the number of calibration streams, options included, and fluid type (gas or liquid). The tables on the next page contain the mounting plate dimensions.

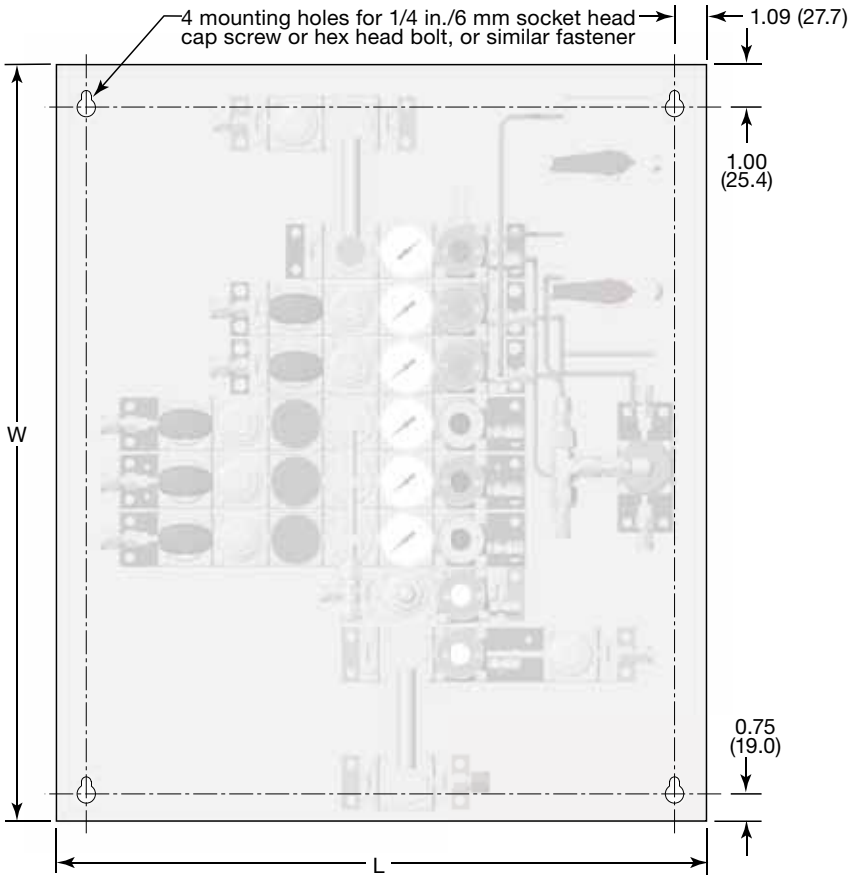
Attach with fasteners with a maximum diameter of 1/4 in. or 6 mm (not provided) in the four mounting holes on the plate.

Note: CSM systems containing flow indicator(s) must be installed vertically, allowing the flow through the flow indicator(s) to be in the upward direction.

Dimensions, in inches (millimeters) are for reference only and are subject to change.



CSM Configuration	A in. (mm)
CSM with flow indicator or relief valve	6.80 (173)
CSM with flow loop inlet assembly	8.75 (222)



Mounting

Dimensions, in inches (millimeters) are for reference only and are subject to change.

Plate Dimension L

Inlet Stream Configuration Designator	Dimension L, in. (mm)				
	Bypass Option				
	No	No	Yes	Yes / No	Yes / No
	Manual Calibration				
	No	No	No	Yes	Yes
	Outlet Designator				
	3, X	1, 2, A	All	3, A, X	1, 2
F Filter (FIA)	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	23.0 (584)
G Gauge (GIA)	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	23.0 (584)
L Flow loop (LIA), 1 inlet	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)
L Flow loop (LIA), 2 inlets	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
L Flow loop (LIA), 3 or more inlets	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)	34.0 (864)
P Pressure regulator (PIA)	15.0 (381)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)
R Relief valve (RIA)	15.0 (381)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)
V Valve (VIA)	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	23.0 (584)

Plate Dimension W

Number of Inlet Streams	Dimension W, in. (mm)						
	Bypass Option						
	No	No	Yes	Yes	Yes	No	Yes
	Manual Calibration						
	Yes / No	Yes / No	No	No	Yes	Yes / No	Yes / No
	Outlet Designator						
	2, X	1	X	1, 2	1 , 2 , X	3, A	3, A
2	12.0 (305)	15.0 (381)	12.0 (305)	18.0 (457)	18.0 (457)	15.0 (381)	18.0 (457)
3	12.0 (305)	15.0 (381)	15.0 (381)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)
4	15.0 (381)	15.0 (381)	15.0 (381)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)
5	18.0 (457)	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)	23.0 (584)	23.0 (584)
6	18.0 (457)	18.0 (457)	18.0 (457)	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)
7	18.0 (457)	18.0 (457)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)
8	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)
9	23.0 (584)	23.0 (584)	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
10	23.0 (584)	23.0 (584)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
11	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)
12	28.0 (711)	28.0 (711)	28.0 (711)	34.0 (864)	34.0 (864)	34.0 (864)	34.0 (864)

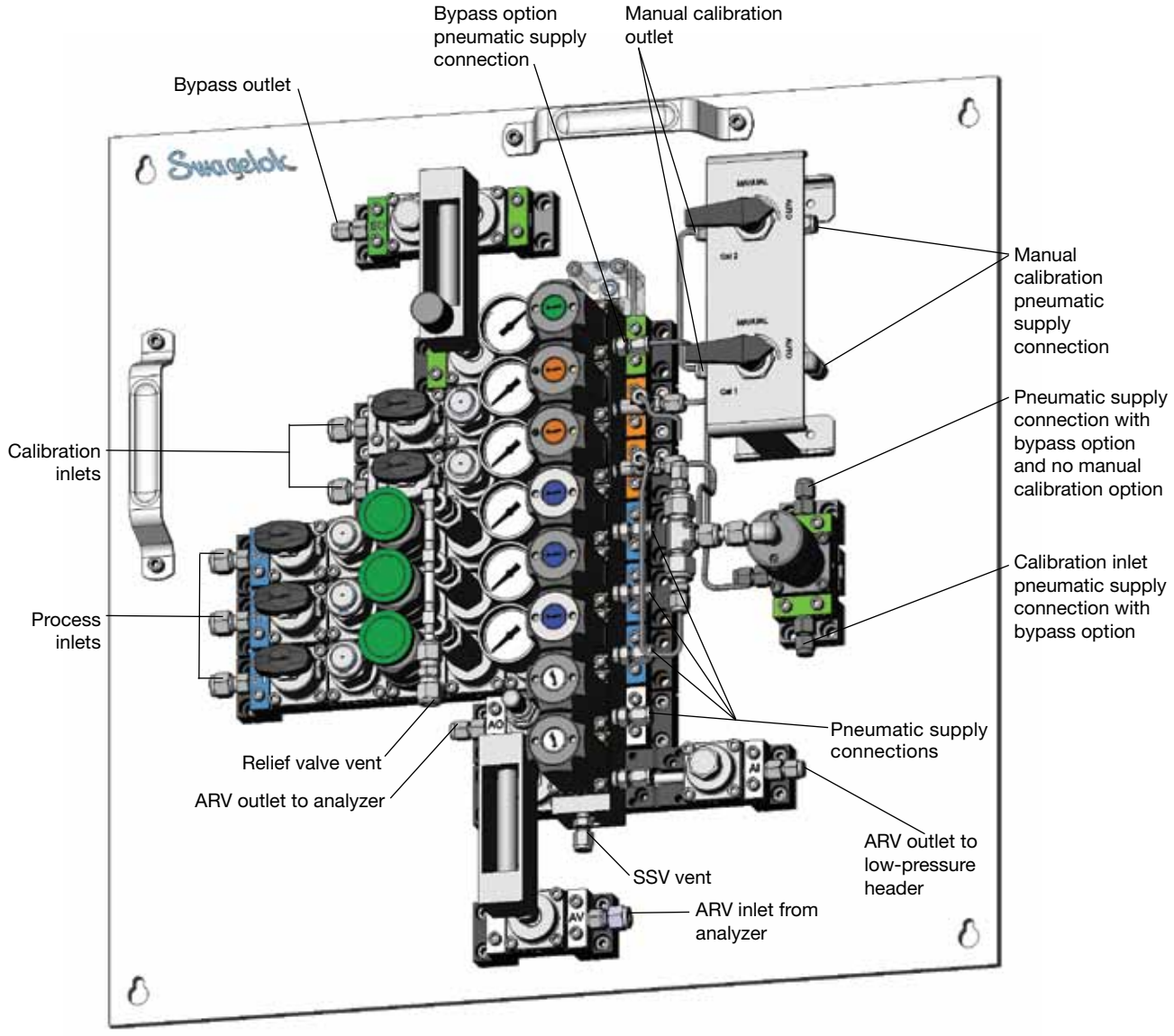
Installation

The assemblies within the CSM are color coded:

Blue	Process sample assemblies
Orange	Calibration assemblies
Green	Bypass assemblies
White	Outlet assemblies

Note: Close all inlet ball valves before connecting the CSM to your system.

Assemble all connections according to the *Swagelok Tube Fitting Instructions for 1 in. (25 mm) and smaller fittings*, page 25.


Bypass option pneumatic supply connection
Manual calibration outlet
Bypass outlet
Manual calibration pneumatic supply connection
Pneumatic supply connection with bypass option and no manual calibration option
Calibration inlets
Calibration inlet pneumatic supply connection with bypass option
Process inlets
Pneumatic supply connections
Relief valve vent
ARV outlet to analyzer
ARV outlet to low-pressure header
SSV vent
ARV inlet from analyzer

Gas System
shown with Bypass, ARV, and Manual Calibration Options

Installation

Connecting Inlets of the CSM

Process inlets (all assemblies except for flow loop inlet assembly)

Connect the tubing from the process sample line to the tube fitting adjacent to the blue lockdown bar on the inlet assembly. The bar identifies each sample stream. The fitting size is either 1/4 in. or 6 mm.

Process inlet, flow loop

Connect the tubing from the process line to the tube fitting with the blue tag on the inlet assembly. The bar identifies each sample stream. The fitting size is either 1/4 in. or 6 mm.

Return Connection, flow loop

Connect the tubing leading to the process return to the flow loop assembly at the tube fitting adjacent to the blue lockdown bar on the flow loop assembly. The bar identifies each sample stream. The fitting size is either 1/4 in. or 6 mm.

Installation

Calibration inlets

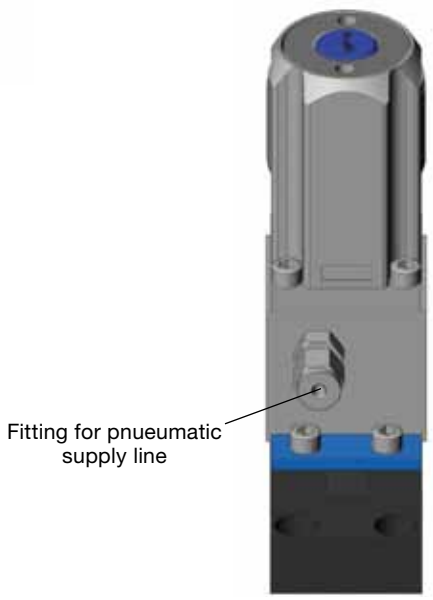
Connect tubing from the calibration source to the tube fitting adjacent to the orange lockdown bar. The bar identifies each calibration stream. The fitting size is 1/8 in. or 3 mm.

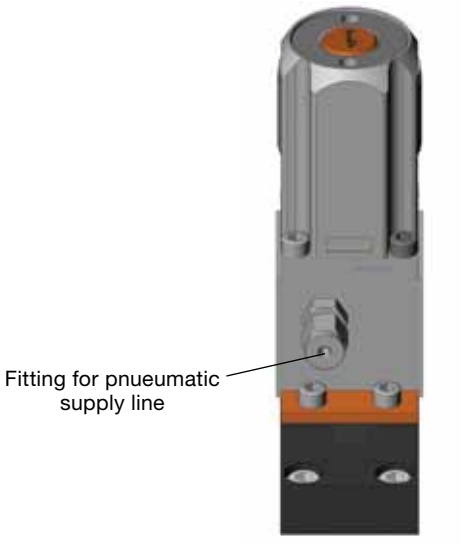
SSV actuator pneumatic inlets

1. Connect the pneumatic supply line to the fittings on the side of the SSV actuator. The fitting size is 1/8 in. or 3 mm.

   The working pressure range is 40 to 150 psig (2.8 to 10.3 bar) for CSM systems without the bypass option and 40 to 100 psig (2.8 to 6.8 bar) for systems with the bypass option.

   Note: If your CSM includes the manual calibration option, there will be no direct connection to the calibration inlet SSV pneumatic actuators.





Installation

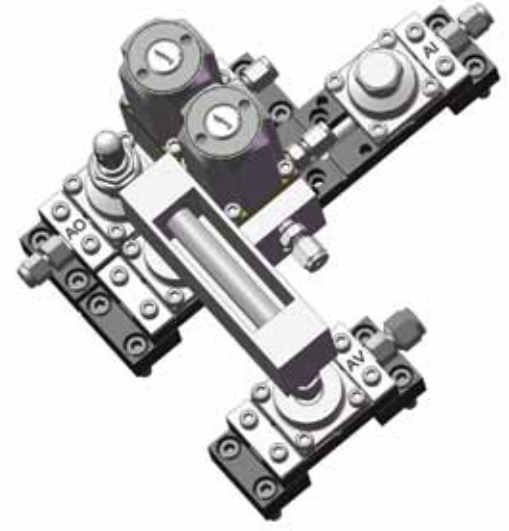
Connecting Outlets of the CSM

Your CSM will have one of the following outlet configurations.

ARV outlet configuration

System connections - the fitting size is either 1/8 in. or 3 mm.

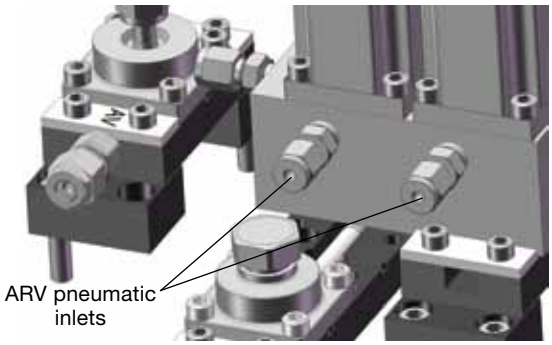
2. Connect the tubing leading to the process analyzer to the tube fitting adjacent to the white lockdown bar marked “AO”.
3. Connect the tubing coming from the process analyzer to the tube fitting adjacent to the white lockdown bar labeled “AI”.
4. Connect the tubing leading to the reference vent to the tube fitting adjacent to the white lockdown bar labeled “AV”.



ARV outlet, SSV actuator pneumatic inlet

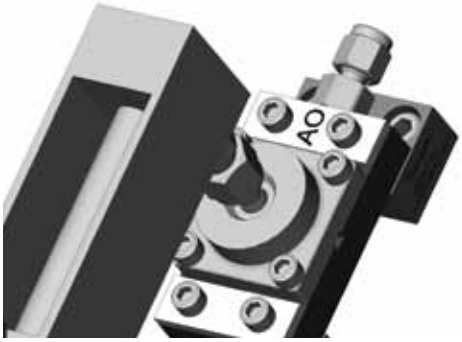
Connect the tubing to the two tube fittings adjacent to the white lockdown bar. Connect the tubing to the pneumatic supply line. The fitting size is either 1/8 in. or 3 mm.

Note: Use the same supply line as the process inlets for the ARV SSV actuators to ensure simultaneous actuation.



Outlet configuration 1, upstream flowmeter

Connect the tubing leading to the process analyzer to the tube fitting adjacent to the white lockdown bar labeled “AO”. The fitting size is either 1/8 in. or 3 mm.



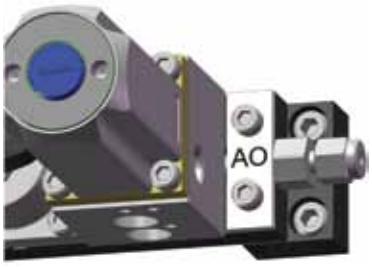
Outlet configuration 2, upstream metering valve

Connect the tubing leading to the process analyzer to the tube fitting adjacent to the white lockdown bar marked “AO”. The fitting size is either 1/8 in. or 3 mm.

Installation

Outlet configuration 3, downstream flowmeter

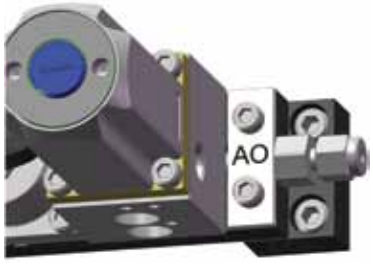
1. Connect the tubing leading to the process analyzer to the tube fitting adjacent to the white lockdown bar labeled “AO”. The fitting size is either 1/8 in. or 3 mm.



2. Connect the tubing leading from the process analyzer to the tube fitting adjacent to the white lockdown bar labeled “AI”.
3. Connect the tubing leading back to the process or disposal to the tube fitting adjacent to the white lockdown bar labeled “REC”.

Outlet configuration X, no flow control

Connect the tubing leading to the process analyzer to the tube fitting adjacent to the white lockdown bar labeled “AO”. The fitting size is either 1/8 in. or 3 mm.



Connecting Remaining CSM Connections

System vent connections

1. Connect the system vent on the SSV end block to a sample disposal. The fitting size is either 1/8 in. or 3 mm.

   Note: See *Stream Selector System For Process Analyzer Applications*, MS-02-326, for information on an alternate vent location.

2. Connect the vents from the relief valves in pressure regulator inlet assemblies, relief inlet assemblies, and flow loop inlet assemblies to a sample disposal. The fitting size is either 1/4 in. or 6 mm.

Bypass option (when present)

1. Connect the tubing leading to the system bypass outlet to the tube fitting adjacent to the green lockdown bar labeled “BO”. The fitting size is either 1/4 in. or 6 mm.

2. CSMs without manual calibration option: connect the pneumatic supply line to the fitting adjacent to the green lockdown bar labeled “PNI”. The fitting size is 1/8 in. or 3 mm.

Manual Calibration Option

Installation

The manual calibration option is available with one or two calibration inlets. It can be operated in three different modes, depending on your system and the desired function.

All fittings are either 1/8 in. or 3 mm. Assemble all connections according to the *Swagelok Tube Fitting Instructions for 1 in. (25 mm) and smaller fittings*, page 25.

Mode 1 — Automatic and Manual Calibration with an Independent Pneumatic Supply

Two Calibration Inlets

1. Connect a pneumatic supply line to A.
2. Remove the installed plugs and connect the pneumatic signal line(s) from the analyzer to B and ‘C.
3. Verify there is a plug in D.

One Calibration Inlet

1. Connect a pneumatic supply line to A.
2. Remove the installed plug and connect the pneumatic signal line(s) from the analyzer to B.
3. Verify there is a plug in D.

Notice

The analyzer is in control of the sample inlets and the calibration inlet when not set to MANUAL. There is the possibility of a mixture of calibration and/or sample fluids if the analyzer sends a signal to the CSM.

Mode 2 — Automatic and Manual Calibration with the Pneumatic Supply to Analyzer Routed through Manual Calibration Assembly

Note - The purpose of this mode is to prevent inadvertent pneumatic signals from the analyzer to the CSM inlets. The ARV option must still be connected to a pneumatic supply line to allow those SSV’s to open.

Two Calibration Inlets

1. Connect a pneumatic supply line to A.
2. Remove the installed plugs and connect the pneumatic signal line(s) from the analyzer to ‘B and ‘C.
3. Remove the installed plug and connect the pneumatic supply line going to the analyzer to D.

One Calibration Inlet

1. Connect a pneumatic supply line to A.
2. Remove the installed plug and connect the pneumatic signal line(s) from the analyzer to B.
3. Remove the installed plug and connect the pneumatic supply line going to the analyzer to D.

Mode 3 — Manual Calibration only

Two Calibration Inlets

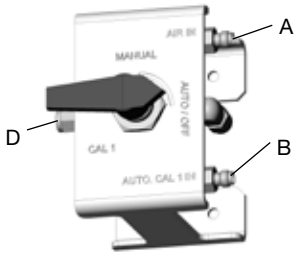
1. Connect a pneumatic supply line to A.
2. Verify there are plugs in B, C, and D.

One Calibration Inlet

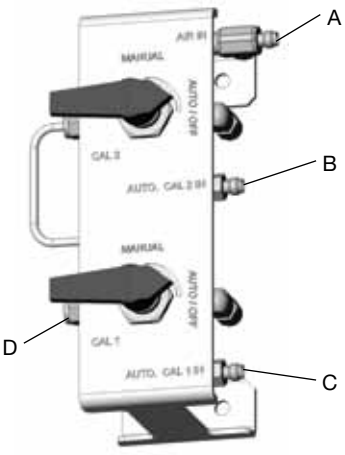
1. Connect a pneumatic supply line to A.
2. Verify there are plugs in B and D.

Notice

The analyzer will remain in control of the sample inlets and the calibration inlet not set to MANUAL. There is the possibility of a mixture of calibration and/or sample fluids if the analyzer sends a signal to the CSM.



One Calibration Inlet



Two Calibration Inlets

System Startup

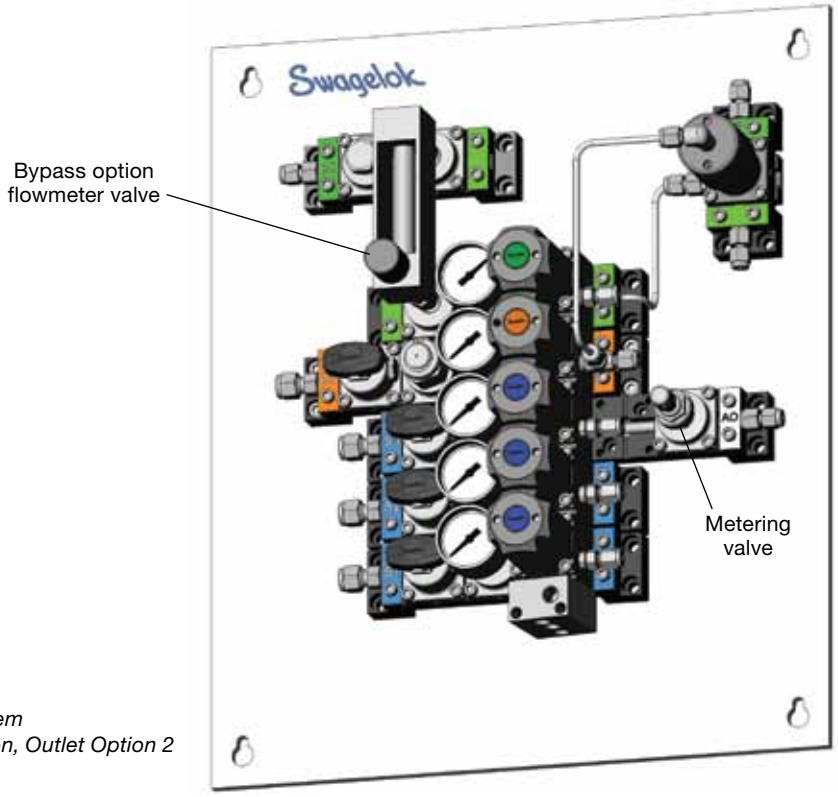
1. CSM with flow loop inlet assemblies or the bypass option - open the metering valve(s) on the flowmeter(s) by turning the handle counterclockwise until it stops.
2. Shut off the flow to the analyzer by turning the metering valve handle clockwise until it stops. (For outlet configurations 1 and 3 the metering valve is on the flowmeter.)

   Note: Outlet configuration X does not contain a flow control device to the analyzer.
3. Open all of the sample inlet ball valves.

   Note: Flow loop sample inlets will display flow on the flowmeter(s). Flow can be adjusted by turning the handle of the metering valve on the flowmeter clockwise to decrease flow or counter clockwise to increase flow.
4. For systems with pressure regulator inlet assemblies, adjust all of the sample inlet regulators to the same pressure to maintain similar flow rates to the analyzer.
5. Send a pneumatic signal to the first sample inlet SSV actuator to confirm valve actuation.

   For systems with the bypass option, you should see full flow to the bypass flowmeter. Open the analyzer metering valve until the desired flow rate is indicated on the analyzer flowmeter. Bypass flow can be adjusted by partially closing the bypass metering valve.
6. Close the inlet SSV actuators by removing the pneumatic signal.
7. Repeat steps 5 and 6 for the other sample inlets.
8. Open all of the calibration inlet ball valves.
9. Send a pneumatic signal to the first calibration inlet SSV actuator to confirm valve actuation.

   For systems with the bypass option, the bypass SSV should be closed and you should see no flow to the bypass valve.
10. Close the calibration SSV actuators by removing the pneumatic signal.
11. Repeat steps 9 and 10 for the other calibration inlet.



Gas System
shown with Bypass Option, Outlet Option 2

Operation

1. Verify all sample and calibration inlet ball valves are open.
2. The sample and calibration inlet SSV valves will be opened by your control system (not included).
3. Adjust the flow loop assembly or the bypass flow rate by opening or closing the metering valve on the flowmeter(s) on those lines as needed.
4. Adjust flow to the analyzer by turning the metering valve handle counterclockwise to increase flow or clockwise to decrease flow. (For outlet configurations 1 and 3 the metering valve is on the flowmeter.)

   Note: Outlet configuration X does not contain a flow control device to the analyzer.
5. To isolate an inlet, close that inlet's ball valve.
6. For a pressure regulator inlet, turn the regulator handle clockwise to increase the pressure or counter clockwise to decrease the pressure.

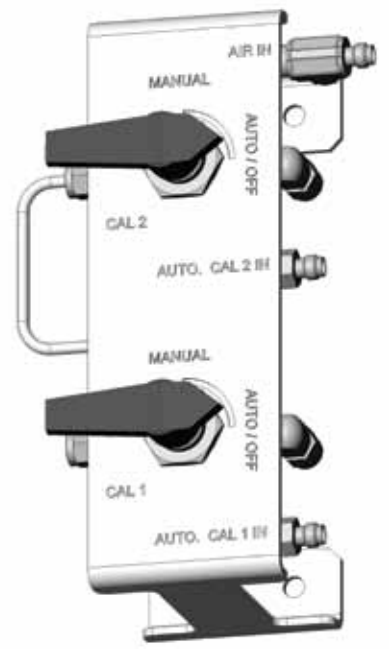
Manual Calibration Option

For *Modes 1 and 2*, the calibration inlet stream actuator(s) are connected to the pneumatic signal lines coming from the analyzer when the calibration valve(s) are in the AUTO/OFF position. This allows calibration to be controlled by the analyzer. For *Mode 3*, manual calibration only, the AUTO/OFF position for this mode is off, as there are no calibration pneumatic signal connections made to the analyzer.

- For normal operation, place the CAL 1 valve and the CAL 2 valve in the AUTO/OFF position.
- To select calibration stream 1 for analysis by the process analyzer, rotate the CAL 1 valve to the manual position, leaving the CAL 2 valve in the AUTO/OFF position.
- To select calibration stream 2 for analysis by the process analyzer, rotate the CAL 2 valve to the MANUAL position, leaving the CAL 1 valve in the AUTO/OFF position.

Note: The system is not intended to have both manual calibration valves simultaneously placed in the MANUAL position

Note: Any manual or automatic calibration activity will shut off the bypass stream, preventing loss of calibration fluids through the bypass stream.



Maintenance

Warning

Before servicing any installed system component you must
- **purge the system**
- **depressurize the system.**

Follow these steps to depressurize your CSM:

1. Close the isolation valves upstream of the process inlet.
2. Close the calibration source flow upstream of the calibration inlets.
3. Open the ball valves on all sample inlet and calibration inlets.
4. Systems with a Pressure Regulator Inlet Assembly — Adjust the pressure regulators to an acceptable pressure. Do not leave the regulators in the closed position.
5. Open the metering valves on the sample assembly outlet and the bypass outlet flow meter.
6. Open the sample inlet and calibration inlet SSV valves by applying a pneumatic signal to each SSV actuator.
7. Depressurize the CSM by opening a vent regulator or vent valve downstream of the CSM.
8. Prior to disassembly, confirm that there is no pressure in the line(s) downstream of the bypass or ARV check valve(s).

Periodically check the operation of system relief valves using one of the following methods:

Relief Valve in System

1. Connect a variable pressure source to the sample assembly inlet.
2. Slowly increase the pressure until the valve opens.
3. Decrease the pressure until the valve closes.
4. If the valve does not open at the set pressure (factory set to 75 % of the pressure gauge range), remove the valve from the system according to steps 1 through 3 of **Relief Valve Removed From System**.
5. Remove the outlet adapter from the top of the valve, tighten or loosen the adjusting screw as necessary, then replace the outlet adapter. Reverse steps 1 through 3 of **Relief Valve Removed From System** and reinstall the relief valve. Alternatively, replace the relief valve.

Relief Valve Removed from System

1. When multiple inlets are present, remove the relief valve outlet header.
2. Unscrew the screws attaching the relief valves to the substrate and remove the valves from the substrate.
3. Remove the modular adapters and exhaust manifold from the valves.
4. Connect each valve to an external pressure supply (1/4 in. NPT connection) and a suitable exhaust header (1/4 in. Swagelok tube fitting connection).
5. Slowly increase the pressure until the valve opens.
6. Decrease the pressure until the valve closes.
7. If proper operation has been observed, reverse steps 1 through 3 and reinstall the relief valve.

   If the valve does not open at the set pressure (factory set to 75 % of the pressure gauge range), remove the outlet adapter from the top of the valve, tighten or loosen the adjusting screw as necessary, then replace the outlet adapter. Reverse steps 1 through 3 and reinstall the relief valve. Alternatively, replace the relief valve.

Maintenance

System Component	Reference for Replacement Ordering Information
Ball Valve (42T series)	*Modular Platform Components (MPC),* MS-02-185
Check Valve (CH series)	*Modular Platform Components (MPC),* MS-02-185
Filter (TF series)	*Modular Platform Components (MPC),* MS-02-185
Filter element	*Filters,* MS-01-92
Metering Valve (M series)	*Modular Platform Components (MPC),* MS-02-185
Pressure regulator (KCP series)	*Modular Platform Components (MPC),* MS-02-185
Relief valve (KVV series)	*Pressure Regulators,* MS-02-230
Pressure indicator (M model pressure gauge)	*Modular Platform Components (MPC),* MS-02-185
Stream selector valve (SSV series)	*Modular Platform Components (MPC),* MS-02-185 *Stream Selector System for Process Analyzer Applications,* MS-02-326
Flow indicator (G1 and M1 series variable area flowmeter)	*Variable Area Flowmeters,* MS-02-346

Troubleshooting

Symptom	Cause	Remedy
Flowmeter to the analyzer is indicating low flow.	The filter in the open stream is obstructed.	Clean or replace the filter element or the filter.
	The metering valve is adjusted incorrectly.	Adjust the metering valve setting by turning the handle counterclockwise to increase the flow.
	The inlet regulator is adjusted too low. (If process stream of your CSM is not a pressure regulator inlet assembly, this is the regulator upstream of the CSM.)	Adjust the regulator setting by turning the handle clockwise to increase the pressure.
	The system supply flow rate to the CSM has decreased.	Check and adjust the flow upstream of the CSM as necessary.
Flowmeter to the analyzer is indicating high flow.	The metering valve is adjusted incorrectly.	Adjust the metering valve setting by turning the handle clockwise to decrease the flow.
	The inlet regulator is adjusted too high.	Adjust the regulator setting by turning the handle counterclockwise to lower the pressure.
	The system supply flow rate to the CSM has increased.	Check and adjust the flow upstream of the CSM as necessary.
Bypass flowmeter is indicating low flow.	The metering valve is adjusted incorrectly.	Adjust the metering valve setting by turning the handle counterclockwise to increase the flow.
	The filter in the open stream is obstructed.	Clean or replace the filter element or the filter.
Bypass flowmeter is indicating high flow.	The metering valve is adjusted incorrectly.	Adjust the metering valve setting by turning the handle clockwise to decrease the flow.
Flow loop inlet assembly flowmeter is indicating low flow.	The metering valve is adjusted incorrectly.	Adjust the metering valve setting by turning the handle counterclockwise to increase the flow.
	The inlet regulator is adjusted too low.	Adjust the regulator setting by turning the handle clockwise to increase the pressure.
	The system supply flow rate to the CSM has decreased.	Check and adjust the flow upstream of the CSM as necessary.

Troubleshooting

Symptom	Cause	Remedy
Flow loop inlet assembly flowmeter is indicating high flow.	The metering valve is adjusted incorrectly.	Adjust the metering valve setting by turning the handle clockwise to decrease the flow.
	The inlet regulator is adjusted too high.	Adjust the regulator setting by turning the handle counterclockwise to lower the pressure.
	The system supply flow rate to the CSM has increased.	Check and adjust the flow as necessary.
A sample inlet pressure gauge is indicating low pressure.	The filter in the open stream is obstructed.	Clean or replace the filter element or the filter.
	The inlet regulator is adjusted too low.	Adjust the regulator setting by turning the handle clockwise to increase the pressure.
	The system supply flow rate to the CSM has decreased.	Check and adjust the flow upstream of the CSM as necessary.
A sample inlet pressure gauge is indicating high pressure.	The inlet regulator is adjusted too high.	Adjust the regulator setting by turning the handle counterclockwise to lower the pressure.
	The system supply flow rate to the CSM has increased.	Check and adjust the flow upstream of the CSM as necessary.
A calibration inlet pressure gauge is indicating low pressure.	The filter in the open stream is obstructed.	Clean or replace the filter element or the filter.
	The calibration supply gas is running low.	Replace the calibration supply gas.
A calibration inlet pressure gauge is indicating high pressure.	The calibration supply pressure is set too high.	Lower the calibration supply pressure.
The analyzer returns readings significantly different than expected.	Process fluid mixes with calibration fluid during manual calibration.	Adjust the operating procedure for calibration to ensure no inlet stream will be selected during manual calibration.
		Verify the appropriate manual calibration mode has been selected for your system.

Troubleshooting

Symptom	Cause	Remedy
A SSV valve piston does not fully actuate.	The pneumatic supply line pressure is below 40 psig (2.8 bar).	Increase the pneumatic supply line pressure.
	The SSV valve is not functioning properly.	Replace the valve seals according to *SSV Series Assembly and Service Instructions*, page 27.
	Manual calibration option - the valve is set to manual.	Turn valve handle to AUTO/OFF.
	The pneumatic control system is not functioning properly.	Check the pneumatic control system.

Swagelok Tube Fitting Instructions for 1 in. (25 mm) and smaller fittings

Fig. 1

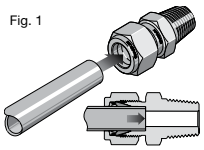


Fig. 2

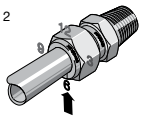


Fig. 3

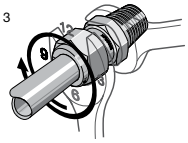


Fig. 4

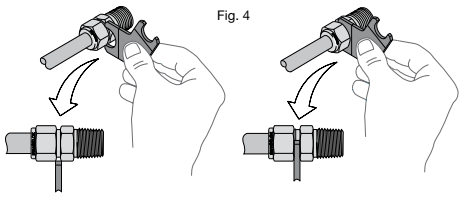


Fig. 5

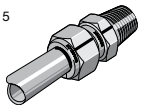


Fig. 6

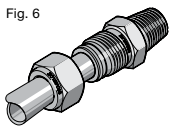
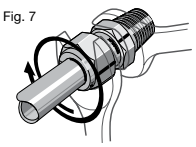


Fig. 7



Installation
These instructions apply to both traditional fittings and to fittings with the advanced back-ferrule geometry.

1. Fully insert the tube into the fitting and against the shoulder; rotate the nut finger-tight. *Fig. 1*.
   High-Pressure Applications and High Safety-Factor Systems: Further tighten the nut until the tube will not turn by hand or move axially in the fitting.
2. Mark the nut at the 6 o'clock position. *Fig. 2*.
3. While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position. *Fig. 3*.
   Note: For **1/16, 1/8,** and **3/16 in.; 2, 3,** and **4 mm** tube fittings, tighten the nut three-quarters turn to the 3 o'clock position.

Gaugeability
On initial installation, the Swagelok gap inspection gauge assures the installer or inspector that a fitting has been sufficiently tightened.

Position the Swagelok gap inspection gauge next to the gap between the nut and body. *Fig. 4*.

- If the gauge will not enter the gap, the fitting is sufficiently tightened.
- If the gauge will enter the gap, additional tightening is required.

Reassembly Instructions — You may disassemble and reassemble Swagelok tube fittings many times.

⚠ **Warning**
Always depressurize the system before disassembling a Swagelok tube fitting.

1. Prior to disassembly, mark the tube at the back of the nut; mark a line along the nut and fitting body flats. *Fig. 5*.

Use these marks to ensure you return the nut to the previously pulled-up position.

2. Insert the tube with preswaged ferrules into the fitting body until the front ferrule seats against the fitting body. *Fig. 6*.
3. While holding the fitting body steady, rotate the nut with a wrench to the previously pulled-up position as indicated by the marks on the tube and the flats; at this point you will feel a significant increase in resistance. *Fig. 7*.
4. Tighten the nut slightly.

⚠ **Caution**
Do not use the gap inspection gauge with reassembled fittings.

⚠ **Caution**
Do not mix or interchange parts with those of other manufacturers.

For additional information, see the *Gaugeable Tube Fittings and Adapter Fittings* catalog, MS-01-140.

40 Series Valve Packing Adjustment

IMPORTANT

This valve is adjusted for factory testing with nitrogen at 1000 psig (69 bar) or the rated pressure if lower than 1000 psig (69 bar). Packing must be readjusted for service at higher than test pressure. ⚠ **Warning: Packing adjustment may be required during the service life of the valve to prevent leakage.** Before servicing any installed valve you must depressurize the system, cycle the valve, and purge the valve. Adjust the packing by turning the packing bolt clockwise in 1/16-turn increments until leak-tight performance is achieved. Always verify proper operation upon installation.

SSV Series
Assembly and Service Instructions

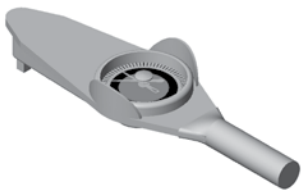
Contents

- Tool Requirements 1
- Components and Hardware. 2
- Port and Mounting Dimensions . . 3
- General SSV Assembly 4
- Mounting MPC-Style Assemblies 5
- Adding / Removing Base Blocks 5
- Flange Replacement 5
- Cap Replacement. 6
- O-Ring Replacement 6

Tool Requirements

Torque Wrench, 0 to 45 in.·lb (0 to 5.1 N·m) with hex drivers:

- 7/64 in.
- 9/64 in.
- 5/32 in.



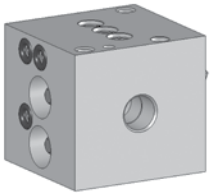
O-Ring Pick (or similar tool)

SSV Series
Assembly and Service Instructions

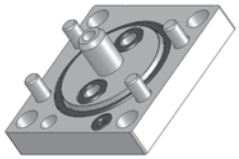
Components and Hardware

Base Block

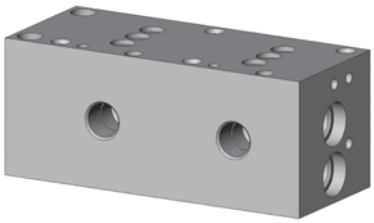
· Standard
· Outlet
· MPC Standard
· MPC Outlet



Flange

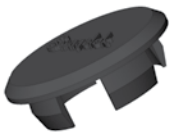


ARV Base Block



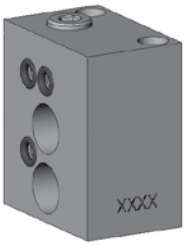
Cap

· Ten per bag of chosen color



End Base Block

· Right
· Left



Screws

· Standard
· MPC mounting
· Flange
· Insert

Module

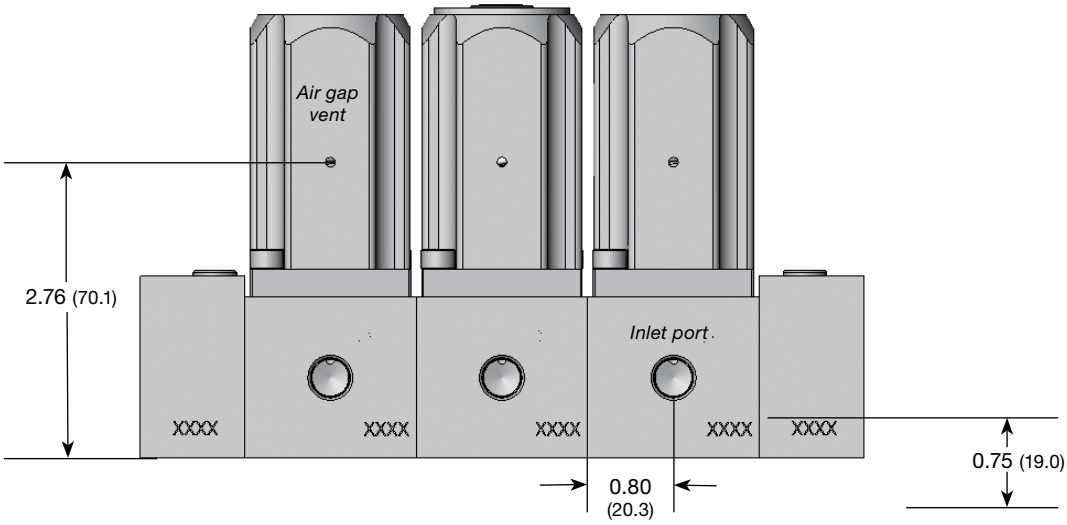
· DBB
· ARV

O-Rings

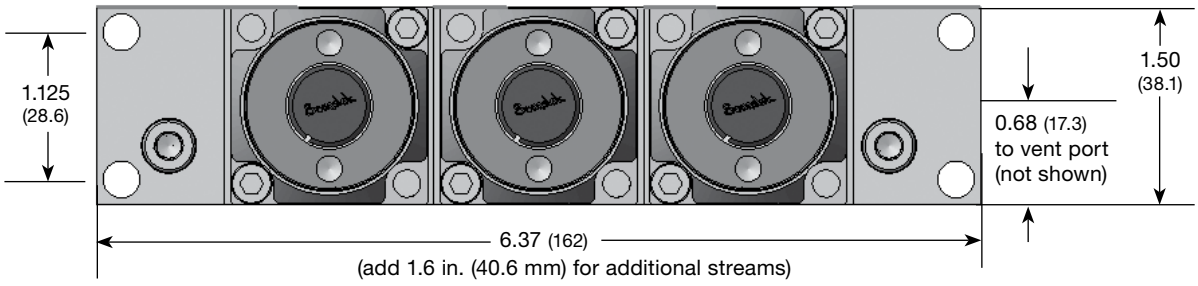
· Three 9-004
· Eight 9-007
· One 9-022

SSV Series
Assembly and Service Instructions
Port and Mounting Dimensions

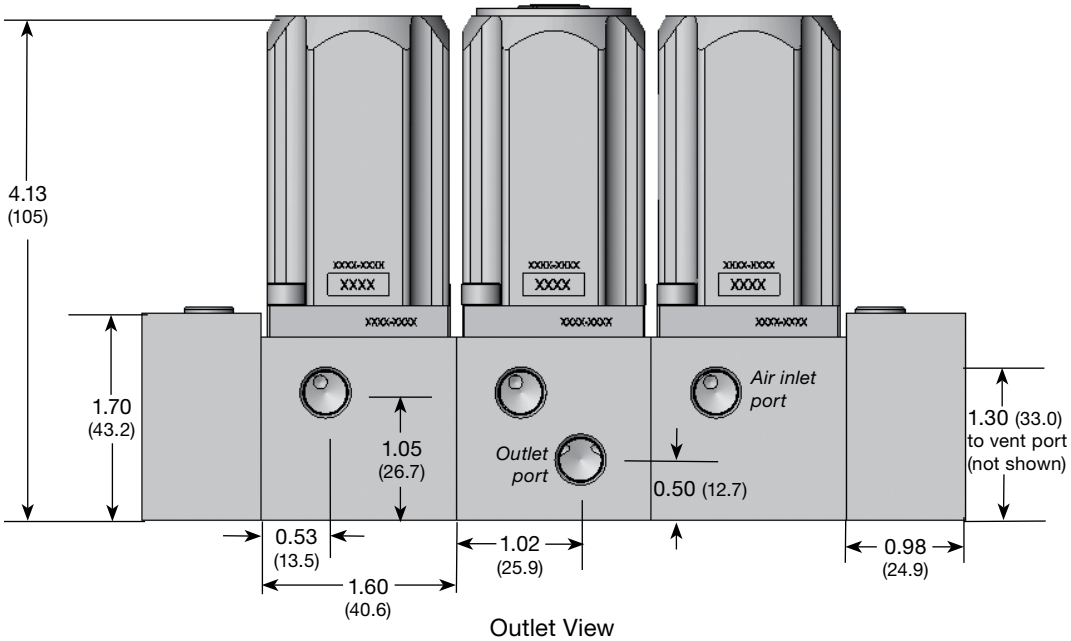
Dimensions, in inches (millimeters), are for reference only and are subject to change.



Inlet View



Top View



Outlet View

SSV Series
Assembly and Service Instructions

General SSV Assembly

1. Place a **left end base block** in a vise.
   Note: For assemblies using an ARV base block, the ARV block is in place of a left end base block.

2. Place a **base block** on the **left end base block**, aligning the **O-rings** (9-007) with the through ports. The square end of the left end base block inserts will be located in the counterbores of the base block. See Fig. 1.

3. Tighten the two base block insert screws to the two left end base block inserts using a 9/64 in. **hex torque wrench** placed through the **base block inserts** to 35 to 45 in.·lb (4.0 to 5.1 N·m). See Fig. 2.

4. Continue building the **base block** assembly by repeating steps 2 and 3, tightening the base block insert screws to the adjacent **base block inserts**. Place the **outlet base block** in the desired position within the base block assembly.
   ⚠ **Caution**
   Do not intermix standard and MPC-style base blocks.

   Note: It is recommended that the outlet base block be assembled close to the center of the assembly for the most consistent flow results.

5. Assemble a **right end base block** to the assembly, aligning the right end base block **O-rings** (9-007) with the through ports on the last base block. Tighten the right end base block insert screws to the base block inserts to 35 to 45 in.·lb (4.0 to 5.1 N·m) using a 9/64 in. hex torque wrench placed through the end base block. See Fig. 3.

6. Install a **DBB module** on each **base block** with the **alignment pin** fitting into the alignment hole on the DBB module. Using two **mounting screws** (#10-32 x 1/2 in. with standard 5/32 in. hex drive) tighten the DBB module to the base block to 25 to 35 in.·lb (2.8 to 4.0 N·m). See Fig. 4.
   Note: For ARV assemblies, install only ARV modules to the ARV base blocks.

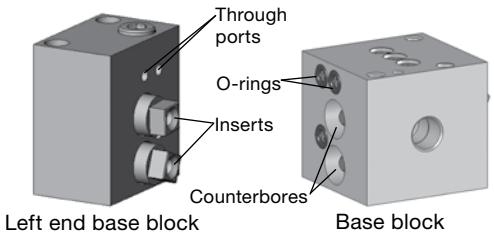


Fig. 1

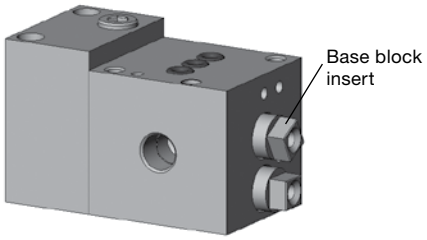


Fig. 2

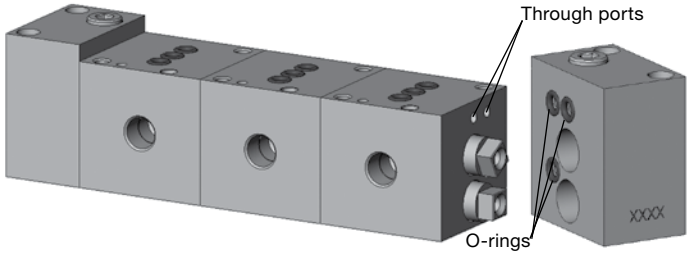


Fig. 3

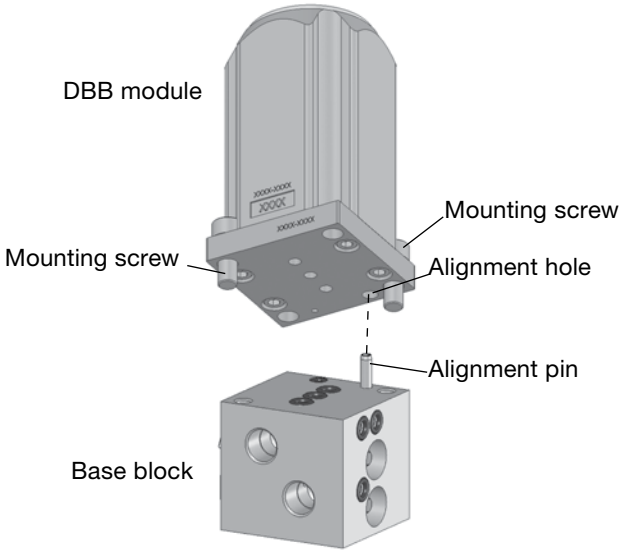


Fig. 4

SSV Series
Assembly and Service Instructions

Mounting MPC-Style Assemblies

For MPC-style assemblies, install the entire **SSV assembly** to the panel using **MPC mounting screws** (#10-32 x 2.0 in. with standard 5/32 in. hex head), aligning the **fluid port holes** on the SSV assembly and the **panel**. Torque the screws to 25 to 35 in.·lb (2.8 to 4.0 N·m). See Fig. 5.

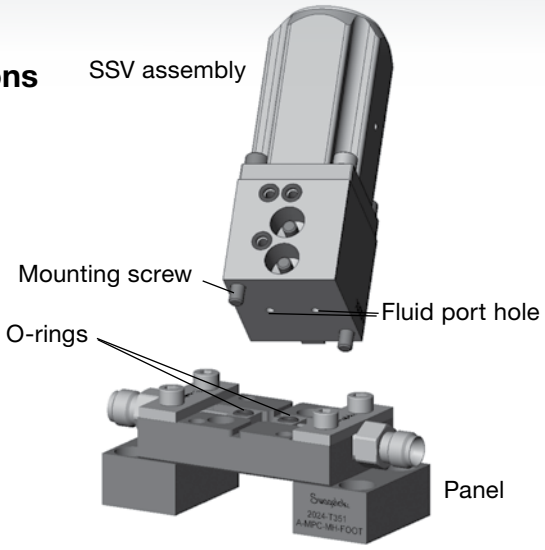


Fig. 5

Adding / Removing Base Blocks

1. Remove the insert screws from the right end base block. Add (according to step 4 of **General SSV Assembly**) or remove the desired number of base blocks using a 9/64 in. hex tool.
2. Replace the right end block according to step 5 of **General SSV Assembly**.
3. Install any needed DBB modules per step 6 of **General SSV Assembly**.

Flange Replacement

1. Using a 5/32 in. hex torque wrench, loosen the **mounting screws** and remove the **DBB module** from the base block.
2. Using a 7/64 in. hex torque wrench, loosen the **flange screws** and remove the **flange** from the **DBB module**.
3. Align the **air inlet** and **alignment pin holes** on the new **flange** with those on the bottom of the DBB module. See Fig. 6.

⚠ **CAUTION**
The air inlet and alignment pin holes on the flange and valve must be oriented correctly for the DBB module to function correctly after reassembly.

4. Replace the **flange screws** and tighten (10 to 15 in.·lb, 1.1 to 1.7 N·m).
5. Attach the **DBB module** to the **base block** per step 6 of **General SSV Assembly**.

⚠ **WARNING**
Before servicing any installed valve you must:
- **depressurize the system**
- **cycle the valve**
- **purge the valve.**

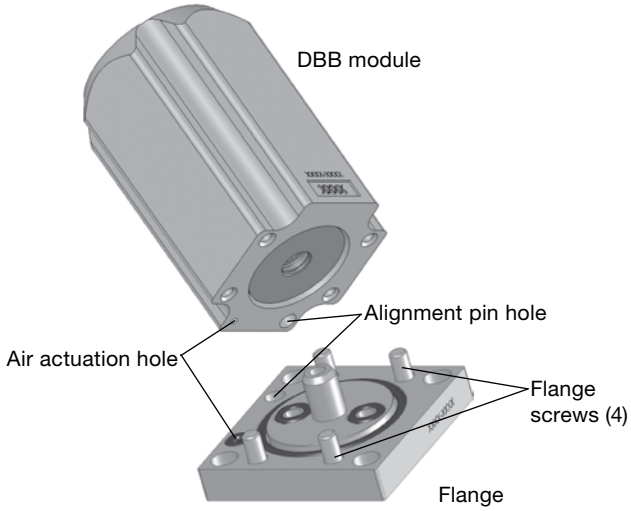


Fig. 6

SSV Series
Assembly and Service Instructions

Cap Replacement

1. Use an O-ring pick or similar tool to remove the existing cap.
2. Press the new **cap** into the **groove** so that the **tabs** are compressed within the **undercut** of the **piston**. See Fig. 7.

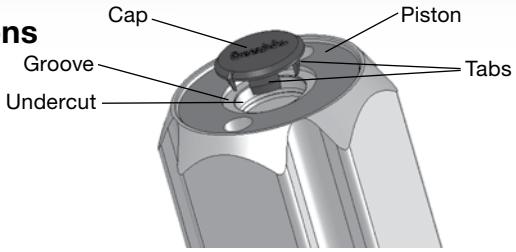


Fig. 7

O-Ring Replacement

1. To replace **base block seals** or **right end base block seals** (9-007), remove block(s) according to **Adding/ Removing Base Blocks**. See Fig. 8.
2. To replace the **DBB module face seals** (9-007), remove the module from the base block according to step 1 of **Flange Replacement**. See Fig. 8.
3. To replace the **DBB module body seal** (9-022) or **actuation air seal** (9-004), remove the module and flange according to steps 1 and 2 of **Flange Replacement**. See Fig. 9.
4. Remove the O-ring from the counterbore using an O-ring pick or similar tool.

   ⚠ **CAUTION**
   Be careful not to scratch the counterbore surface with the removal tool. System performance could be affected by any scratches.

5. For the **DBB module body seal** (9-022) only, lubricate the new O-ring with the provided lubricant.
6. Press the new O-ring(s) into the appropriate counterbore.
7. Reassemble the SSV assembly according to the section followed for disassembly.

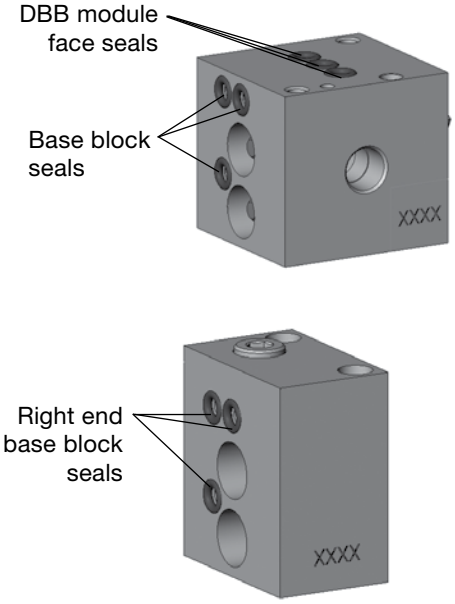


Fig. 8

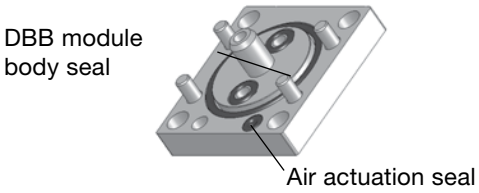


Fig. 9

Testing

Perform a shell test and check for proper operation prior to system installation.

Safe Product Selection

When selecting a product the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

Caution: Do not mix or interchange parts with those of other manufacturers.

TF Series Tee-Type Filter Service Instructions

Kit Contents

Gasket Kit

Gasket

Element Kit

Filter element

Label

⚠ WARNING

Before servicing any installed filter you must

- **depressurize system**
- **purge the filter to remove any residual system media.**

⚠ WARNING

Residual system media may be left in the valve.

Tools Required

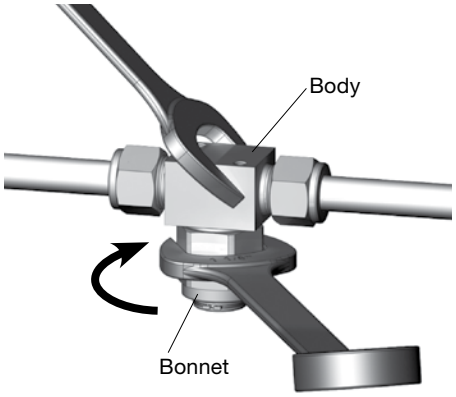
Tool	Size	Component
Open-ended wrenches	2TF, 4TF: 1 in. 6TF, 8TF: 1 1/8 in.	Bonnet, Body
Crow's foot	2TF, 4TF: 1 in. 6TF, 8TF: 1 1/8 in.	Bonnet
Torque wrench	Capable of 650 in.·lb (73.4 N·m)	Bonnet

Definition of Symbols

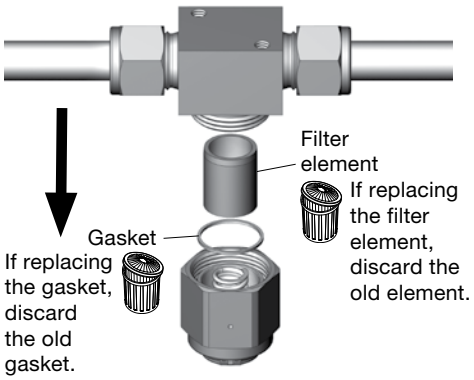
Discard

Disassembly

1. Isolate the filter from the system.
2. Stabilize the **body** with a wrench. Loosen the **bonnet**.

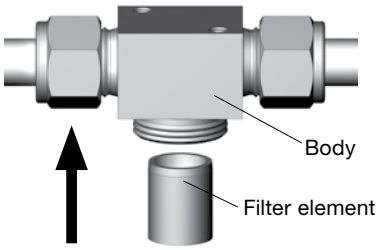


3. Remove the components.

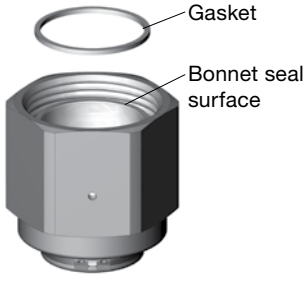

Filter element
If replacing the filter element, discard the old element.
Gasket
If replacing the gasket, discard the old gasket.

Reassembly

4. Clean all of the components.
5. Press the open end of the **filter element** into the **body**.



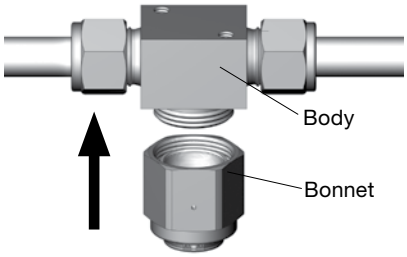
6. Center the **gasket** on the **bonnet seal surface**.



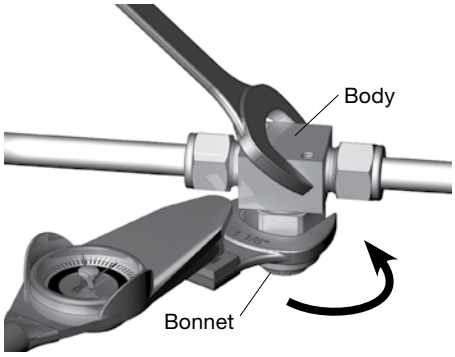
TF Series Tee-Type Filter Service Instructions

7. Thread the **bonnet** onto the **body** until the body threads are no longer visible**.**

   Note: If the bonnet does not fully thread onto the body, the gasket is not centered on the bonnet seal surface.



8. Stabilize the **body** with a wrench. Tighten the **bonnet** according to table below.



Series	Torque, in.·lb (N·m)	
	Stainless Steel	Brass
2TF, 4TF, 3TF-MM, 6TF-MM	550 (62.2)	450 (50.8)
6TF, 8TF, 8TF-MM, 10TF-MM, 12TF-MM, 14TF-MM	650 (73.4)	475 (53.7)
All using PCTFE gasket	1/4 turn past finger-tight	

9. Place the new label on the filter body.
10. Test the product for proper operation.

F Series Inline Filter Service Instructions

Kit Contents

Gasket Kit

Gasket

Element Kit

Filter element

Label

⚠ WARNING

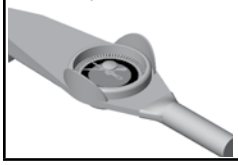
Before removing a filter from the system for service, you must

- **depressurize system**
- **purge the filter to remove any residual system media.**

⚠ WARNING

Residual system media may be left in the filter.

Tools Required

Tool	Size	Component
Open-ended wrenches	2F: 9/16 in. 4F: 3/4 in. 6F, 8F: 1 in.	Body hex
Crow's foot	2F: 9/16 in. 4F: 3/4 in. 6F, 8F: 1 in.	Body hex
Torque wrench 	Capable of 500 in.·lb (56.5 N·m)	Body hex

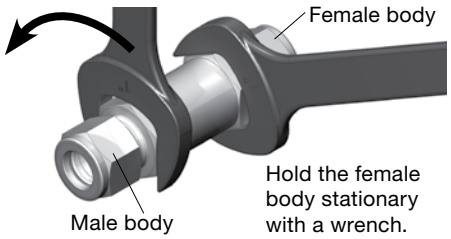
Definition of Symbols

Discard

F Series Inline Filter Service Instructions

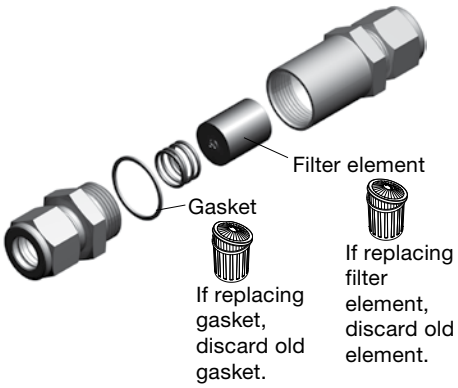
Disassembly

1. Remove the filter from the system.
2. Loosen the **male body** from the **female body**.



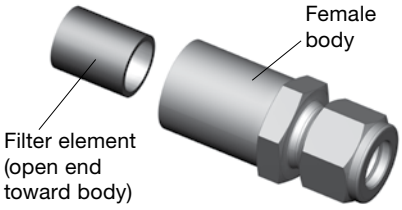
3. Remove the components.

   Note: Use a blunt tool to loosen the filter element if necessary.

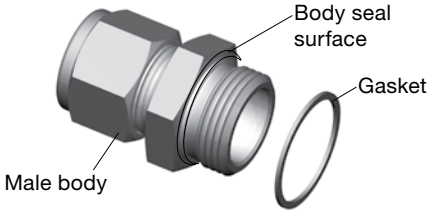


Reassembly

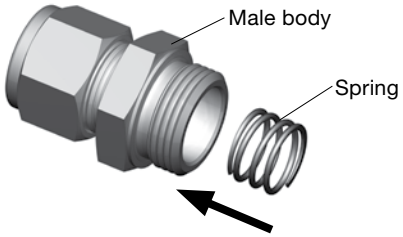
4. Clean all components.
5. Press the open end of the **filter element** into the **female body**.



6. Place the **gasket** on the **body seal surface** of the **male body**.

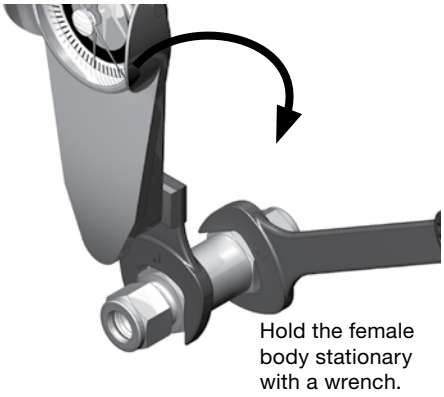


7. Insert the **spring** into the **male body**.



8. Thread the bodies together.

   Note: There will be no space between the gasket and the male body hex when the bodies are fully threaded.
9. Tighten the male body according to table below.



Series	Torque, in.·lb (N·m)	
	Stainless Steel, Alloy 400, Alloy C-276, Alloy 600	Brass
1F, 2F, 3F-MM	135 (15.2)	125 (14.1)
4F, 6F-MM	350 (39.6)	325 (36.7)
6F, 8F, 10F-MM, 12F-MM	500 (56.5)	450 (50.8)

10. Place the new label on the female body.
11. Test the product for proper operation prior to reinstallation in system.

KCP Series Regulators Maintenance Instructions

Kit Contents

Seat

Seat retainer

Poppet

Poppet spring

Piston seal

Piston guide seal

High pressure kits only (over 250 psig [17.2 bar])

Filter

Retaining ring

Filter ring

Lubricant (with MSDS)

Tools Required

Tool	Size	Component
Needle-nose pliers	—	Filter
Socket	5/16 in.	Seat retainer
Crow's foot	1 1/4 in.	Body cap
Open-ended wrench	1 1/4 in.	Body cap
Torque wrench	Capable of 15 ft·lb (20.3 N·m, 2.1 m·kg)	Seat retainer
	Capable of 25 ft·lb (160 N·m, 3.5 m·kg)	Body cap

⚠ WARNING

Before removing a regulator from the system for service, you must

- **depressurize system**
- **purge the system to remove any residual system media left in the regulator.**

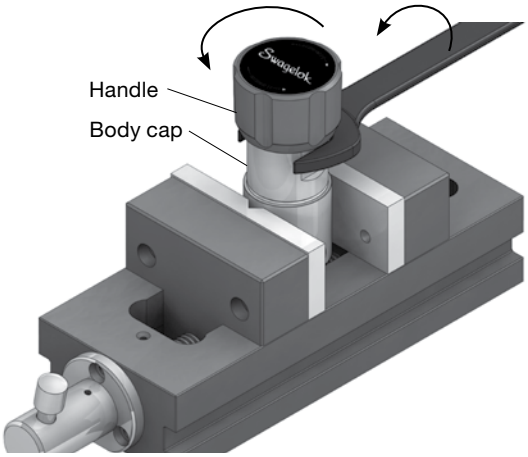
KCP Series Regulators Maintenance Instructions

Disassembly

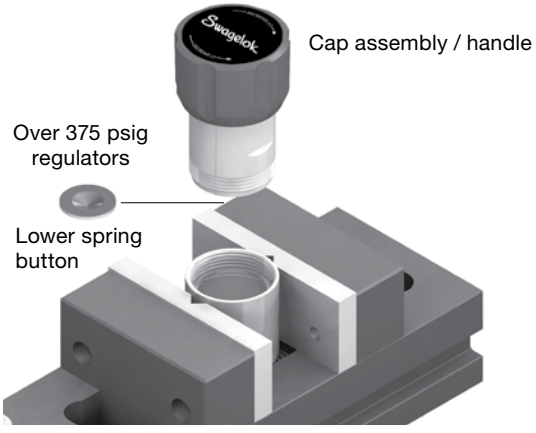
1. Place the regulator in a vise.

   Note: Take precautions to protect the body from being scratched by the vise.

2. Turn **handle** counterclockwise until it stops.
3. Loosen **body cap**.



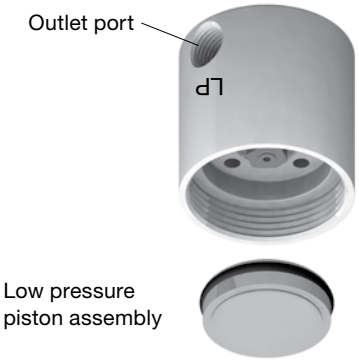
4. Remove **cap assembly** and **handle** as one piece and set aside for later use.



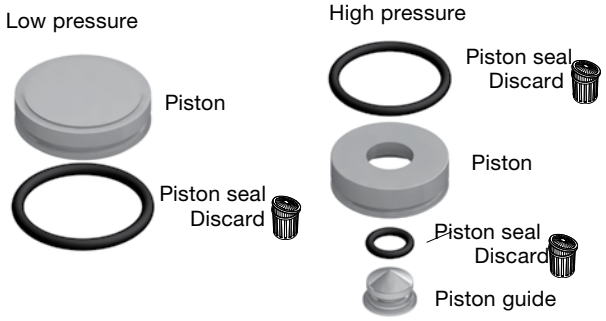
Note: In high-pressure regulators (over 375 psig [25.8 bar]), the **lower spring button** may fall from the cap assembly when lifted. Set aside for later use.

5. Turn body assembly upside down and remove **piston assembly** by applying low-pressure air to an **outlet port** marked 'LP'.

⚠ CAUTION
Applying pressure greater than 5 psig (0.34 bar) could cause personal injury or damage to the piston.

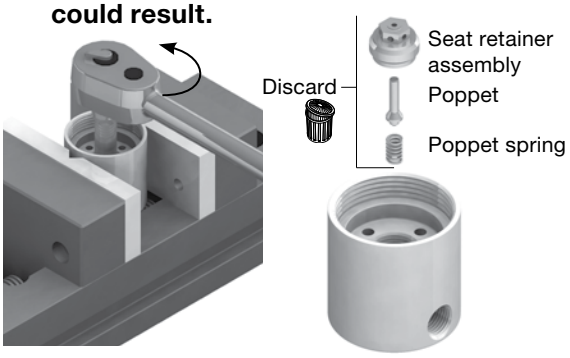


6. Remove the **piston seal(s)**. For high pressure regulators, also remove the **piston guide**.



7. Use socket wrench to remove **seat assembly, poppet,** and **poppet spring**.

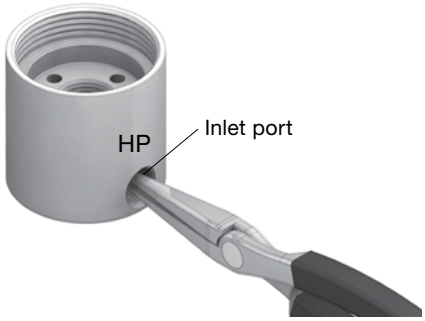
⚠ CAUTION
Be careful not to scratch the inside of the body. Leakage could result.



KCP Series Regulators Maintenance Instructions

Note: If your regulator assembly is used on a Swagelok MPC substrate, proceed to step 10.

8. Use needle-nose pliers or similar tool to remove **retaining ring** from the **inlet port** (marked 'HP').

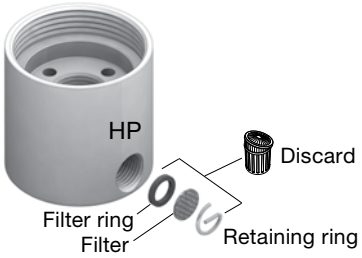


Note: Be careful not to scratch the sides of the inlet port.

9. Remove the **filter ring** and **filter**.

Note: Tap the body by hand to allow the filter ring to fall out.

Note: Prod the filter with the pliers to tip it until the filter falls out.

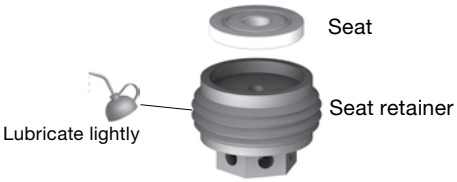


Reassembly

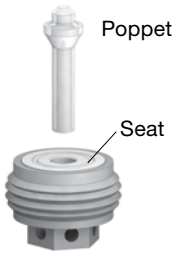
⚠ CAUTION

Ensure all components are free of debris or damage or leakage could result.

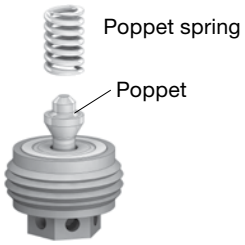
10. Fit the **seat** into the **seat retainer** until flush. Lightly lubricate the threads only.



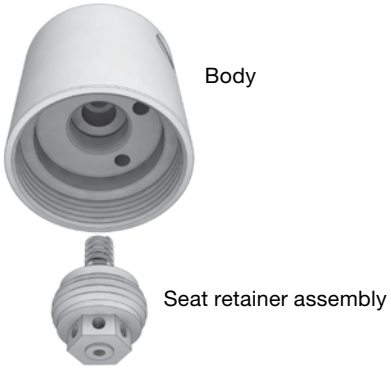
11. Place the **poppet** through the center of the **seat**.



12. Place the **poppet spring** onto the exposed end of the **poppet**.

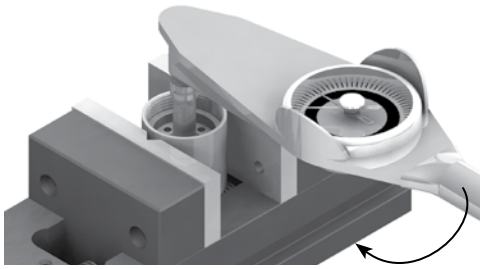


13. Keep the seat retainer assembly inverted with the poppet spring on the top and thread it into the body.

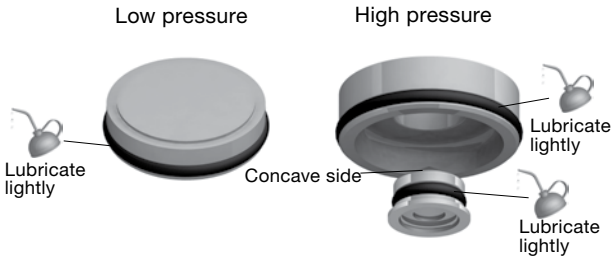


KCP Series Regulators Maintenance Instructions

14. Tighten seat retainer to 15 ft·lb (20.3 N·m, 2.1 m·kg).



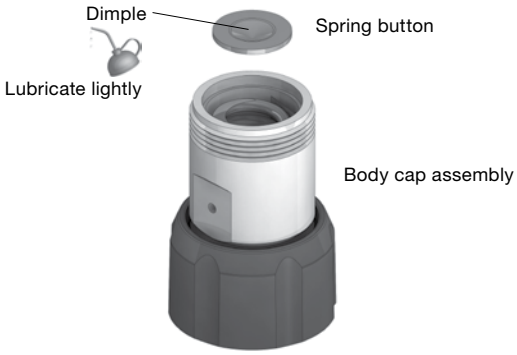
15. Lightly lubricate **piston seal(s)** and install onto **piston**. For the high pressure piston, press the second seal onto the piston guide from the concave side.



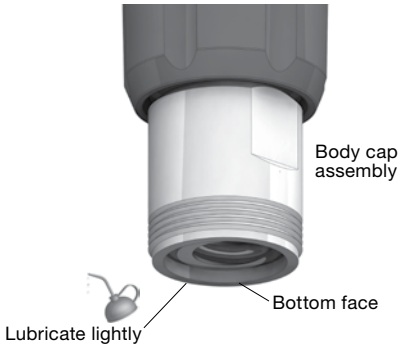
16. Press the **piston assembly** into the **body** until it seats against the seat retainer.

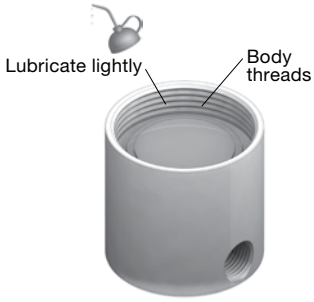
    Note: Do not to damage the piston seals.

17. High pressure regulators only, put a small amount of lubricant in the the **dimple** of the **spring button** and place into the **body cap assembly**.



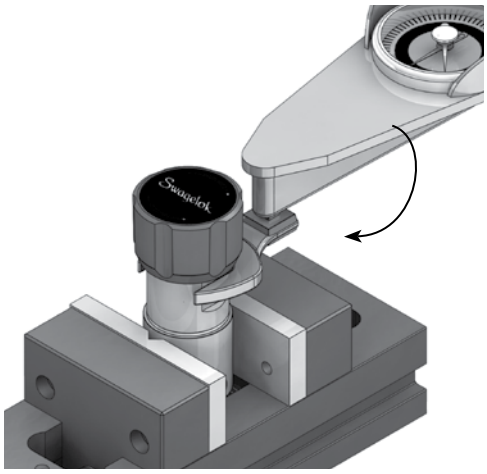
18. Lightly lubricate the **body threads** and the **bottom face** of the **body cap assembly**.





KCP Series Regulators Maintenance Instructions

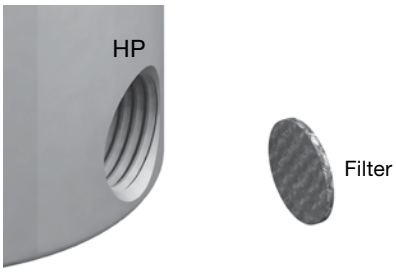
19. Thread body cap assembly onto body. Tighten to 25 ft·lb (160 N·m, 3.5 m·kg).



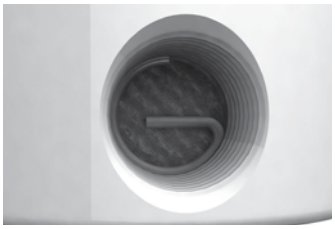
Note: If your regulator assembly is used on a Swagelok MPC substrate, proceed to step 23.

20. Insert **filter ring** in the inlet port (marked ‘HP’).

21. Insert the **filter** into the inlet port with the course mesh facing away from the inside of the regulator.



22. Insert the retaining ring into the inlet port until the ring is fully seated into the groove inside the port.



23. Test and set the regulator for proper operation.

Pressure Regulators User's Guide

Swagelok

⚠ CAUTION

- **SWAGELOK® REGULATORS AND KENMAC® ADJUSTABLE REGULATOR RELIEF VALVES ARE NOT "SAFETY ACCESSORIES" AS DEFINED IN THE PRESSURE EQUIPMENT DIRECTIVE 97/23/EC**
- **DO NOT USE THE REGULATOR AS A SHUTOFF DEVICE.**

Installation

- ***Bottom Mounting***

  Mount the regulator using the two M5 (10-32) mounting holes located on the regulator base.

- ***Panel Mounting***

  ⚠ **Warning**

  Failure to mantain the handle and stem position could result in downstream pressures exceeding the maximum rating of the regulator.

  - Rotate the handle as far down as possible, then rotate back one-quarter turn. Note position of handle notch for reassembly.
  - Holding the handle stationary, loosen and remove the lock nut. Be careful to also keep the stem stationary.
  - Turn the handle counterclockwise to remove.
  - After panel mounting, replace handle and rotate as far down as possible, then rotate back 1/4 turn.
  - Replace and tighten lock nut. Torque to 120 to 150 in.·lbs (13.5 to 16.9 N·m). Hold the handle and stem stationary when torquing lock nut.

- ***Connections to System***

  Before connecting to system, verify the regulator is closed by turning the handle or adjusting screw:

  - counterclockwise, when viewed from above, until it stops for pressure reducing regulators,
  - clockwise, when viewed from above, until it stops for back-pressure regulators.

  ⚠ **Caution**

  Do not allow any loose tape or thread sealant to enter the regulator or fluid stream.

  ⚠ **Caution**

  Verify that the inlet (marked 'HP' for pressure reducing, 'inlet' for back pressure regulators) and outlet (marked 'LP' for pressure reducing, 'outlet' for back pressure regulators) are in the proper orientation.

Operation

Note: All handle directions are when viewed from above.

- Allowances must be made for the differences of back-pressure regulators. Turning the control handle clockwise will increase the upstream pressure, counterclockwise will allow upstream pressure to vent through the regulator.
- Outlet and control pressure settings are obtained by adjusting the handle (or adjusting screw).
  - To increase the outlet or control pressure, rotate the handle *clockwise*.
  - To decrease the outlet or control pressure, rotate the handle *counter-clockwise* and vent the downstream side of the regulator.
  - Make the final setting in the direction of increasing pressure to obtain the most accurate set points.
  - Once fluid is flowing through the system, fine tuning may be required.
- Icing of the regulator at high flow rates or high pressure drops may occur if the gaseous media contains moisture.
- An auxiliary upstream filter is recommended for use in all but the cleanest of media.
- When using a liquid media, the internal filter may cause a pressure drop and flow reduction. Removal of the internal filter and the use of a dedicated upstream filter may be necessary.
- Installation of a downstream pressure relief is recommended for regulator and system protection.
- All connections should be checked for leakage. Isolate the downstream (LP for pressure reducing, HP for back-pressure regulators) side of the regulator and turn the handle clockwise enough to pressurize the regulator outlet. Then pressurize the regulator with an inert gas to the pressure marked on the unit and applying a liquid leak detector around the connections and any plugs.

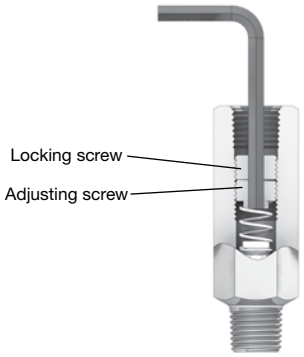
Pressure Regulators User's Guide

⚠ **Warning**

Factory fitted KVV series relief valves are set to zero when assembled to the regulator. Venting of outlet pressure will occur until pressure setting is adjusted by user.

⚠ **Warning**

Reset relief pressure to the desired value before pressurizing the system.



Adjusting the Pressure Setting

1. Using a 5/32 in. or 4 mm hex wrench, loosen the **locking screw** by turning counter clockwise.
2. Slide the hex wrench into the **adjusting screw**.
3. Turn the both screws clockwise to increase the relief pressure, counter-clockwise to decrease, until the desired relief pressure is obtained.
4. Slide the hex wrench back up into the **locking screw** and turn clockwise to lock.
5. Verify relief pressure.

Caution: Do not mix or interchange parts with those of other manufacturers.

Variable Area Flowmeters Installation Instructions G Series and M Series

Glass-tube models, G series

Metal-tube models, M series

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- Safety Information 1
- Installation 2
- Startup 2
- Reading the Flowmeter 2
- Reading the Flowmeter Using a Conversion Factor 2
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Safety Definitions

Potential danger to life or of serious injuries.

Potential for personal injury from electrical shock.

Safety Information

Swagelok variable area flowmeters must be installed, operated, and serviced according to NEC, applicable local regulations, and these instructions. Otherwise, serious personal injuries, damage, or both can occur.

The electrical connections provided on any electronic relays should be used as originally supplied and not bypassed or modifed (other than wire length). Only qualified personnel should work on these products.

Safe Product Use

Follow any enclosed instructions and refer to the product catalog for detailed product information. When using a variable area flowmeter, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user. **Improper selection or misuse of the product may result in serious personal injury or property damage**.

Variable Area Flowmeters Installation Instructions G Series and M Series

Installation

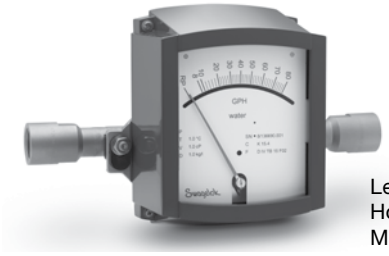
For optimal performance, prior to installation:

- flush out the pipe or tube leading to the flowmeter.
- For gas flow applications, dry the pipe or tube leading to the flowmeter.

The variable area flowmeter must be installed as vertically as possible to ensure the most accurate flow reading, with the exception of the Swagelok MH horizontal model.

G Series
Vertical Mount

Direction of flow is from bottom to top in vertical models and can be either right to left or left to right in horizontal models, as specified when ordering.



Left-to-right
Horizontal
Mount

Align the pipe or tube leading to and from the flowmeter axially with the connections on the flowmeter to keep them free of stress.
If necessary, support the pipe or tube leading to and from the flowmeter to prevent vibration being transmitted to the flowmeter.

Startup

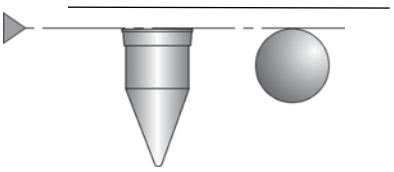
1. For accurate flow measurement, the system media, pressure, and temperature should be consistent with the calibration of the flowmeter.
2. Close the integral metering valve on the flowmeter before the system is pressurized.
   Note: M3 and MH models do not contain an integral metering valve.
3. Open the shutoff valves upstream and downstream of the flowmeter.
4. Add system pressure slowly.

   NOTICE
   Open the metering valve slowly when starting the flow to prevent damage to the float.
5. Adjust the metering valve until the flowmeter shows the desired flow rate.

Reading the Flowmeter

Glass-Tube Models

Glass-Tube flowmeters are read by the position of the float or ball within the flowmeter tube. The flow rate is read at the upper, top edge of the float or ball.



Metal-Tube Models

The flow rate is read with the pointer on the scale or the LED display.

Variable Area Flowmeters Installation Instructions G Series and M Series

Reading the Flowmeter using a Conversion Factor

Flowmeters calibrated for one fluid at a specific pressure and temperature can be used to measure other fluids and different pressures and temperatures by using a conversion factor.

Use the following equation to calculate the conversion factor. Multiply the conversion factor by the flowmeter reading to determine the flow rate for the new conditions.

$$F = \sqrt{\frac{\rho_{cal}}{\rho_{new}}} \times \sqrt{\frac{P_{new}}{P_{cal}}} \times \sqrt{\frac{273 + T_{cal}}{273 + T_{new}}}$$

where

F = conversion factor

ρ_{cal} = fluid density of calibrated scale

ρ_{new} = new fluid density

P_{cal} = pressure of calibrated scale

P_{new} = new pressure

T_{cal} = temperature of calibrated scale, in °C

T_{new} = new temperature, in °C

Note: For temperatures in °F, replace 273 in equation with 460.

Example

Calibrated scale:	*New fluid or conditions:*
ρ = 1.5 kg/m^3	ρ = 1.5 kg/m^3
P = 7 bar	P = 10 bar
T = 30°C	T = 60°C

$$F = \sqrt{\frac{1.5}{1.5}} \times \sqrt{\frac{10}{7}} \times \sqrt{\frac{273 + 30}{273 + 60}} = 1.14$$

Multiply 1.14 by the calibrated scale to determine the flow rate.

Example

The flowmeter reading is 100 L/h.

100 L/h × 1.14 = 114 L/h

Limit Switches

⚠ **Do not wire limit switches for initial installation while system is in operation.**

Up to two limit switches compliant with IEC 60947-5-6 (NAMUR EN 60947-5-6) may be connected to the flowmeter. Connect the limit switch(es) to the desired monitoring device.

Note: When using two limit switches, space the limit switches a mininum of 0.63 in. (16 mm) apart.

Note: Any flowmeter with a limit switch installed must be kept a minimum of 0.24 in. (6 mm) from any moving object containing nickel, iron or cobalt.

Wiring a Limit Switch Without a Junction Box

All Models

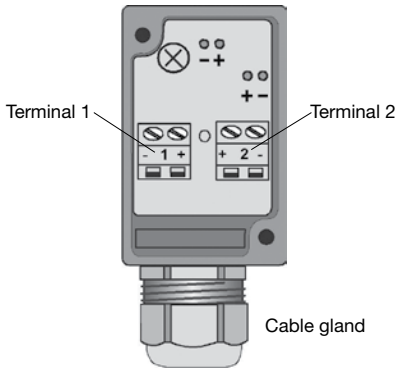
1. Connect the brown wire extending from the flowmeter/limit switch assembly to the positive (+) input of the monitoring device.
2. Connect the blue wire extending from the flowmeter/limit switch assembly to the negative (–) input of the monitoring device.

Variable Area Flowmeters Installation Instructions G Series and M Series

Wiring a Limit Switch With a Junction Box

Glass-Tube Models

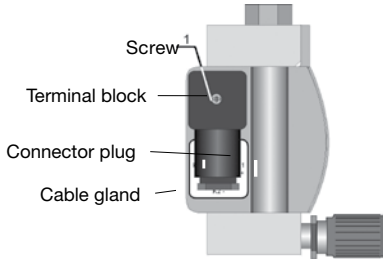
1. Loosen screws and remove the front cover of the junction box.
2. Feed the connecting cable (max 16 AWG or 1.31 mm^2) through the **cable gland** and screw down the cable gland.
3. Connect the positive and negative wires.
   Note: When using one limit switch only, wire to **Terminal 1**.
   When using two limits switches, wire the lower switch to **Terminal 1** and the upper switch to **Terminal 2**.



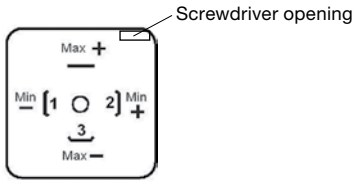
Metal-Tube Models

M1 Model

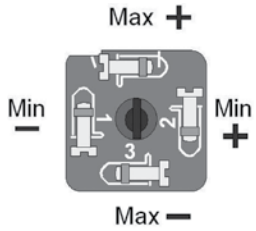
1. Loosen the **screw** on the **connector plug** and remove the plug from the junction box.



2. Remove the screw from the plug.
3. Place a screwdriver in the **opening**, lift and remove the **terminal block**.



4. Feed the connecting cable (max 16 AWG or 1.31 mm^2) through the **cable gland** of the plug and screw down the cable gland.
5. Connect the wires to the positive and negative locations on underside of the terminal block for the minimum, maximum, or both.

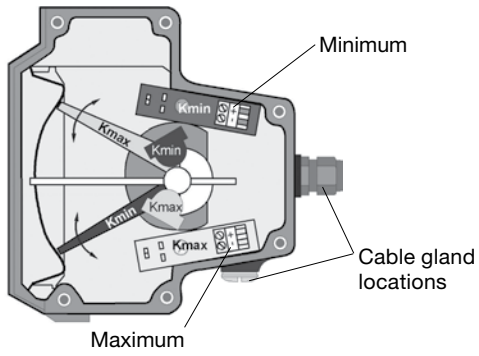


6. Reinstall the terminal block into the plug, snapping in place.
7. Reinstall plug onto junction box and replace the screw. Tighten screw.

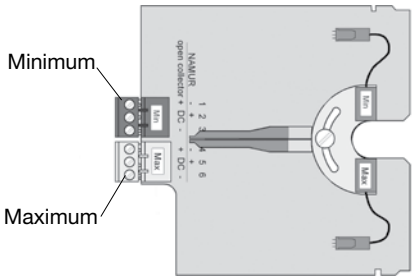
Variable Area Flowmeters Installation Instructions G Series and M Series

M2 , M3, and MH Models

1. Remove the screws and cover from the flowmeter.
2. Feed the connecting wires through the **cable gland** (max 16 AWG) and screw down the cable gland.
3. Connect the wires to the positive and negative locations of the **minimum**, **maximum**, or both.
4. Replace the cover and tighten the screws.



M2 Model



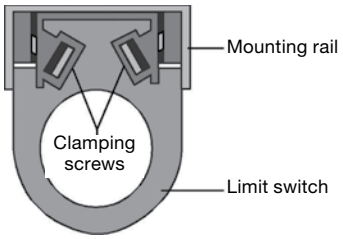
M3 and MH Models

Adjusting a Limit Switch

Limit switches can be adjusted after installation or set during operation.

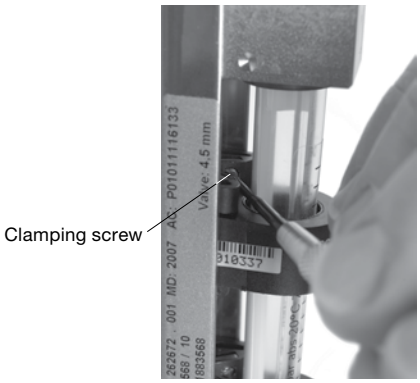
Glass-Tube Models

1. Remove the cover from the flowmeter.
2. Loosen the two **clamping screws** fastening the **limit switch** to the **mounting rail** of the flowmeter.



3. Slide the limit switch along the mounting rail to set the top for a minimum switch, the bottom for a maximum switch, or both if two switches are installed.

   Note: When setting the limit switch, lay the wires so they won't get damaged during use.



4. Tighten the **clamping screws**.
5. Replace the cover.

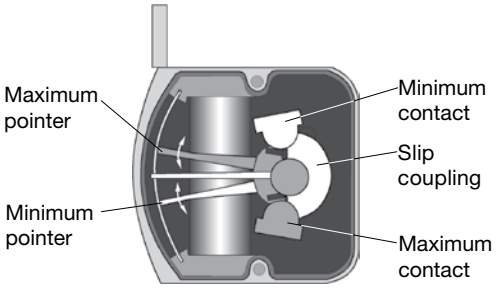
Variable Area Flowmeters Installation Instructions G Series and M Series

Metal-Tube Models

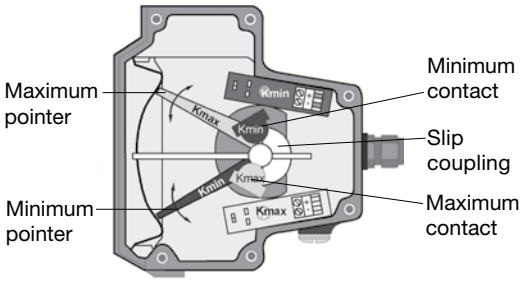
M1, M2, M3, and MH Models

1. Remove the screws and cover from the flowmeter.
2. Slide the **minimum contact**, **maximum contact**, or both along the **slip coupling** to set the corresponding pointers to the desired limit on the scale.
3. Replace the cover and tighten the screws.

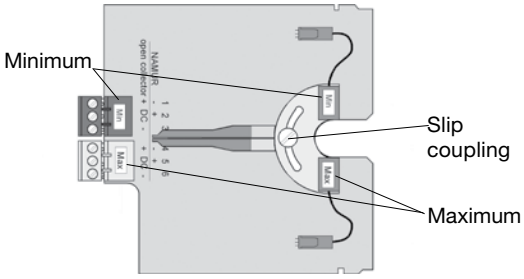
M1 Model



M2 Model



M3 and MH Models

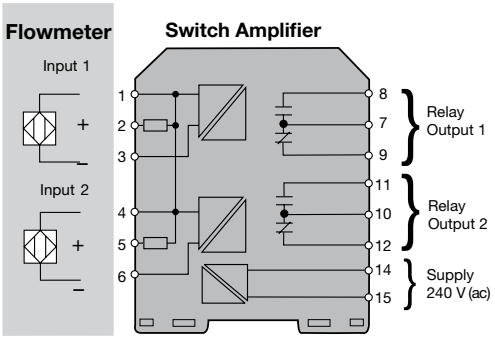


Wiring Limit Switch to a Switch Amplifier With Isolated Relay Output

⚠ **Do not wire limit switches for initial installation while system is in operation.**

Note: The limit switch wires are brown (+) and blue (–).
Note: Additional diagram information is provided for the switch amplifier by the manufacturer.

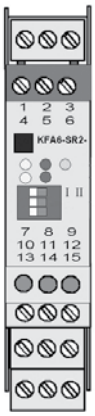
Connection to Customer Switch Amplifier



Connection to Swagelok-Offered Switch Amplifier

One Limit Switch

1. Connect the limit switch to slot 1 (+) and slot 3 (–) of the transistor relay.
2. Connect the outputs of the limit switch to slot 7 and slot 8 for a signal when flow is above the limit switch setting (normally open) or to slot 7 and slot 9 for a signal when flow is below the setting (normally closed).
3. Connect alternating current power to slot 14 (+) and slot 15 (-).



Variable Area Flowmeters Installation Instructions G Series and M Series

Connection to Swagelok-Offered Switch Amplifier

Two Limit Switches

1. Connect the minimum limit switch to slot 1 (+) and slot 3 (–) of the transistor relay.
2. Connect the maximum limit switch to slot 4 (+) and slot 6 (–).
3. Connect the outputs of the minimum limit switch to slot 7 and slot 8 for a signal when flow is above the limit switch setting (normally open) or to slot 7 and slot 9 for a signal when flow is below the setting (normally closed).
4. Connect the outputs for the maximum limit switch to slot 10 and slot 11 for a signal when flow is above the limit switch setting (normally open) or to slot 10 and slot 12 for a signal when below the setting (normally closed).

5. Connect alternating current power to slot 14 (+) and slot 15 (–).

4 to 20 mA Output Signal

⚠ **Do not wire output signal for initial installation while system is in operation.**

This 2-wire system connects the power supply, flowmeter, and monitoring device in a series circuit. This creates a “current loop” with the flowmeter functioning as a measurement device.
The 4 to 20 mA interface requires an auxillary power of 14.8 to 30 V (dc). Swagelok suggests use of a 24 V (dc) power supply.

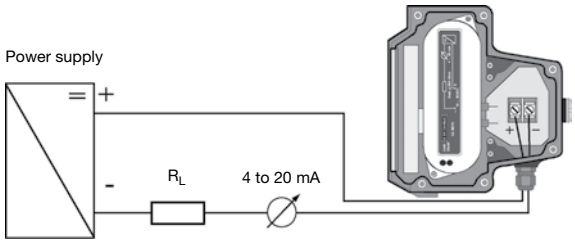
Maximum Load Equations

Milliampere Output Signal, 2-Wire

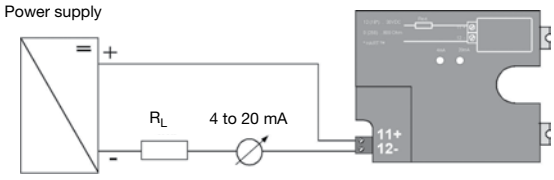
Output	4 to 20 mA
Supply	V = 14.8 to 30 V (dc)
Max load	R_L = (V [dc] – 14.8) / 0.02
Terminals	See drawings

The output will be proportional to the measured flow based on the scale on the flowmeter. Wire the loop according to the appropriate diagram below.

M2 Model



M3 and MH Models



For product technical data, including materials of construction, see the *Swagelok Variable Area Flowmeters* catalog, MS-02-346.

Warranty Information

Swagelok products are backed by The Swagelok Limited Lifetime Warranty. For a copy, visit swagelok.com or contact your authorized Swagelok representative.

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